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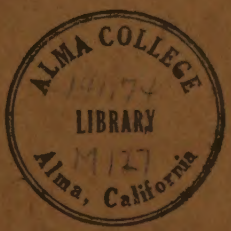
THE MEASUREMENT OF CONATION

An Enquiry Into Volitional Processes

by

RAPHAEL C. McCARTHY, S. J., PH. D.



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INTRODUCTION

AN IMPELLING interest attaches to the study of Human Volition.* No other of man's activities reaches so far in its consequences, both to the individual and to society, as does that of his Will. History is a record of its strivings and achievements and failures. The social and ethical sciences are founded on it. Its importance in education can scarcely be exaggerated. Culture, civilization itself, depends on the regulated volitions, repressions, and inhibitions of individuals and nations. All these activities come under the meaning of the term "Will" as it has been sanctioned by long and universal usage. It is vital, therefore, that our knowledge of Will-activity should be as exact and scientific as possible. Yet there is no field of psychology so slightly tilled as that which deals with Volition. Though Woodworth's complaint is not quite so pertinent now as when he made it twenty-five years ago, it is essentially true today.[1] An enormous amount of work has been done, and very good results achieved, in the domain of sensation, perception, memory, and intelligence; but Will-psychology has languished, and to such an extent that as late as 1923 Lindworsky could write:[2] "At present no historical introduction to experimental researches on the Will can be written; for these have scarcely any history." We do not mean to imply that nothing

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*This paper was submitted in 1925 in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the University of London. The thesis was approved by the University.

[1] "We have nothing in this line that can compare with the immense amount of work done on the relation of perception to the stimulus perceived, or . . . that can compare in completeness with the work done and still being done in all departments of sensation." B. S. Woodworth in The Accuracy of Voluntary Movement. *Psych. Monogr.* Vol. III.

[2] Der Wille, Seine Erscheinung Und Seine Beherrschung, by J. Lindworsky, S. J.

has been attempted and nothing achieved. Some good work has been done in the study of Will-activity as it is manifested in motor or sensori-motor reactions. Sherrington's investigations on Reciprocal Innervation opened new vistas both to physiologists and psychologists; and in recent years the latter have given a good deal of attention to the problem of inhibition in its psychological aspect. Ach's two great researches on the Will gave impetus to a new line of investigation—into volitional activities on a higher level than that of sensory or motor response. Research has also been made on Voluntary Choice since Michotte and Prüm published their classical results. The fact remains, however, that the experimental psychology of Volition has been comparatively neglected.

The reasons for this neglect are various. Many men were attracted to other fields of research through natural preference, or because they were hopeful of more tangible results, or because they were unwilling to cope with the specific difficulties inherent in the task of investigating the Will. A certain class of psychologists recognise neither the need nor the existence of a Will in man. They are of the opinion that they can explain desire, choice, and every other form of volitional activity in terms of muscle and nerve, and of "reaction patterns." Obviously for them study of the "Will" is otiose. Still others explain Will-activity in highly speculative ways. And between these two extremes are hosts of other theories, couched in their authors' own peculiar terminologies and coloured by their particular points of view. The result is the confusion and uncertainty of thought of which Ach complains in the Introduction of his "Ueber den Willensakt und das Temperament." We hope that this work will not add to the confusion. It is an attempt to add a little to what has already been learned by experimental study of the Will.

The problem before us was to study the conscious mental activity during the "time of conflict," when the individual is simultaneously stimulated to contrary courses of action.[3] When

[3] Other problems arose during the course of the research. Some of them are considered in the following pages.

two conflicting inclinations operate in a man, how do these opposing impulses react on each other, and what consciously intervenes ultimately to decide the suppression of one of the impulses and the preponderance of the other? That was the question we proposed to investigate.

The problem has practical value for ordinary life. Such conflicts of impulses are of more than daily occurence; and, though the motives influencing the issue are numerous and varied, the physiological and psychological factors involved are essentially the same. Scarcely anyone lives through a day without being the battleground of a struggle between inclinations—natural or acquired—and a sense of duty or expediency. Man can, and frequently does, react against the enticements of innate tendencies and acquired habit; and yet these may be *far more imperious*, at least in the beginning, than the motive which prompts his final course of action. Hence a study of the period of struggle, even in conditions as artificially simple as those of experiments carried out in the laboratory, may yield useful, practical information.

We have attempted to study the problem both from its quantitative and qualitative sides. We emphasize the latter because introspections furnish us with information about the mental processes, with which we are chiefly concerned, and because they explain, in some degree, the quantitative data.

I welcome this opportunity of expressing my sincere thanks to those who have acted as my Subjects—willingly, though at the price of inconvenience to themselves: Doctor Francis A. P. Aveling, Head of the Department of Psychology; Miss H. M. Wells, B. Sc.; Mr. Boris Stevanovic and Mr. J. A. Tayler; all of the University of London, Kings College. Mr. R. J. Bartlett, M. Sc., Lecturer and Demonstrator in Psychology, University of London, Kings College, did me the favour of acting as Subject on several occasions; but the method of procedure in his case differed from that followed with the other Subjects, and his results do not figure prominently in the tables found in the following pages. The writer also acted as Subject with a view of personally experiencing the phenomena aroused by the con-

ditions of the experiment, and thus possibly arriving at a fuller understanding of what the other Subjects reported in their protocols.

I am further grateful to Doctor Aveling for numerous valuable suggestions, and for the aid he has unfailingly given me both in the course of the experimentation and in the embodying of the data in this paper.

METHOD

With certain modifications, the method of procedure followed in this research was along the lines which have been popular in Will-investigations since the time of Ach's work. The Subjects first formed laboratory-controlled habits, which were to be the basis of the "conflict" in the later experiments. These habits were formed by learning nonsense words. The Subject repeated dissyllabic words aloud and in trochaic rhythm to the beating of a metronome, with a view of establishing associations between the syllables, so that later on the exposure of the first would tend spontaneously to evoke its companion. Ach used pairs of monosyllables; and with them he found that 120 repetitions established so strong an association that it often broke through the Subject's determination to respond according to instructions. Our Subjects repeated the syllables 160 times. Moreover, we used dissyllabic nonsense words, since we thought that two syllables joined together in the same word would be more firmly associated than would the individual components of a pair.

There were in our list ten nonsense words, in which the vowel of the first syllable was always different from that in the second. Ten different vowel sounds were used in the ten initial syllables, which entailed the use of four diphthongs and of Y as a vowel. The words in which the diphthongs were used were made up of six letters, the others of five.

In order to obviate the volitional "set" which might be aroused in the Subject by forewarning him as to the precise nature of his task, we introduced a further modification of Ach's method. His Subjects knew in advance exactly what they were expected to do with the approaching stimulus. We kept ours in ignorance of their specific task until after they had seen the stimulus. We did this by exposing the words in different colours. The stimuli were printed on white cards in letters of uniform size and shape. If they were red they instructed the Subject to rhyme the stimulus. If they were green, he was to transpose the first and last consonant (e. g., the correct response for the

word DOM, when it appeared in green, was MOD). When the word was printed in black, the Subject knew that he had to change the vowel (to give a response DIM, for example, to the black DOM). A blue syllable gave him a choice of rhyming or transposing as he wished. Before the appearance of the stimulus, our Subjects knew neither what the word would be, nor what they were to do with it.

The Subjects were previously familiarized with the meaning of the colours by responding to them with a series of words not used in the later experiments until the Reaction Times for each colour were fairly constant.[1]

In the beginning the initial syllables of eight of the ten learned nonsense words were shown each day, two in each colour. There was no order in the succession of the colours except that a given colour never followed immediately on itself. After the Subject had reacted to each of the colours for all of the ten learned words—when, therefore, he had reacted forty times—a change of procedure was made, for reasons to be given later. Ten new, unlearned nonsense monosyllables were introduced; and each day four of them and four of the old, learned ones were exposed. The conditions of presentation were identical with those described above. Thus in this second set there were ten old syllables and ten new ones with four tasks for each—a total of eighty reactions. For purposes of comparison these ten new syllables were then exposed by themselves, eight daily (two of each colour) on five days.

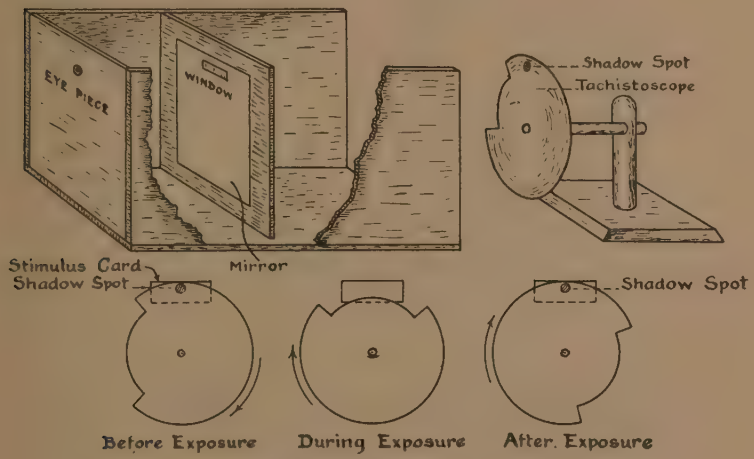
[1] In the preliminary experiments for learning the meaning of the colours, thirty-two exposures—eight of each colour—were made each day. Some Subjects needed more practise than others before their reactions were smooth and the mean variation for the different tasks small. No Subject had less than 120 preliminary experiments. The following Reaction Times (in σ) are averages for the last two days of each Subject's learning reactions.

Subject	*Rhyme*	*Transposition*	*Change of Vowel*	*Choice*
A	914	842	789	1098
B	1405	1279	1081	1557
C	1006	814	771	1032
D	1643	1784	1363	2048
E	953	879	684	1007
F	1069	1554	1274	1867

APPARATUS

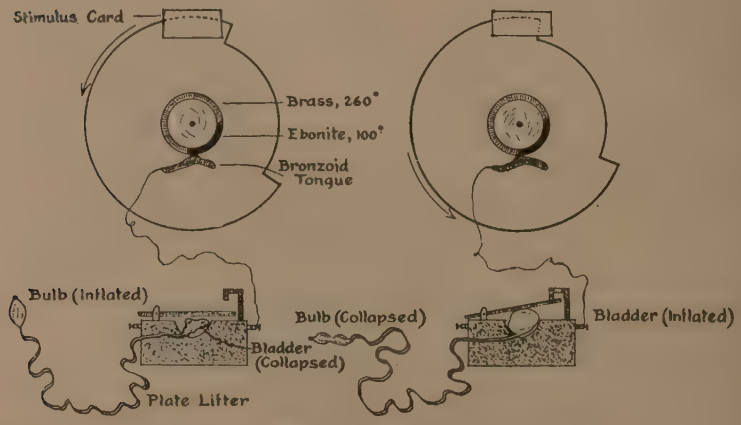
The stimulus word was exposed tachistoscopically. The Subject was seated at a table on which, at a convenient height, was a box open at one end, with an eyepiece at the other. Inside this box was a mirror with a window in its centre which reflected the back of the eyepiece as a dark shadow spot which fixated the Subject's gaze and focussed it in the exact centre of the place where the stimulus would appear.

At the open end of the box and behind the mirror was a wheel of uniform whiteness. It was 22.5 cm. in diameter; and an arc, 30 mm. deep, was cut into its edge. The size of this arc was variable; but all the experiments were made with it open to 100 degrees, for it was found that thus the stimulus was exposed most satisfactorily. When the current through the magnet which held the wheel in place was broken, this arc passed between the Subject and the stimulus word; whereupon the wheel was auto-



WHEEL — FRONT VIEW

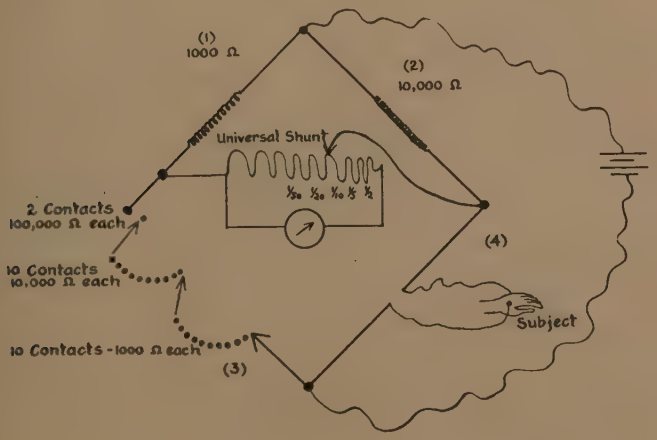
matically caught and held, and the field appeared white as before. The time of exposure, i. e., of fling of the wheel, was 269 sigma with a m.v. of 12 sigma. The Reaction Time was measured by a Hipp chronoscope. The axle of the wheel of the tachistoscope had a collar composed of 260 degrees of brass and 100 degrees of ebonite, flush with each other. While the wheel was held by the magnet before the exposure of the stimulus, the ebonite was gently but firmly pressed by a bronzoid tongue; when the wheel was released or, rather, at the moment that the first letter of the stimulus began to appear, the brass made contact with the bronze tongue, thus making a circuit which started the clock. The clock continued running until the Subject stopped it. This was done by means of an ordinary "plate lifter"—a bulb connected by a long thin rubber tube to a little bladder. When the subject pressed the bulb with his lips and teeth, he inflated the bladder, which was inserted into a pocket of wood. The bladder raised a flexible brass plate to make contact with a copper arm, thus completing the circuit in which the clock was placed. This was found to be a very exact way of measuring the time, for as soon as the Subject began to give his verbal response the pressure on the bulb in his mouth was relaxed, the bladder collapsed, the contact



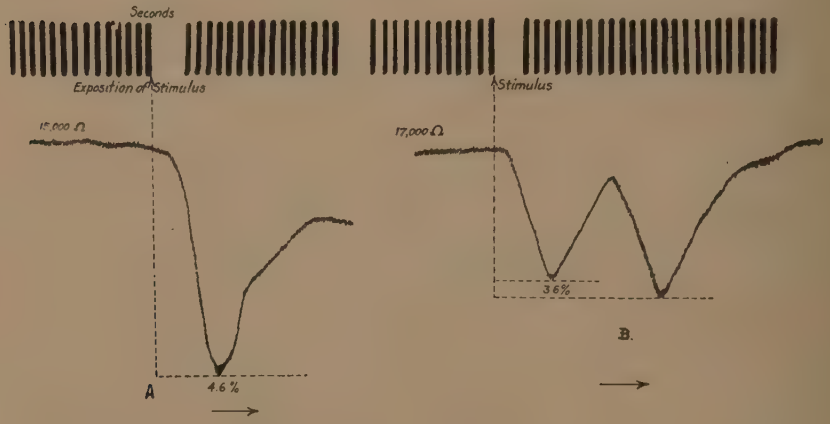
WHEEL—BACK VIEW

was broken, and the clock stopped. One second before the exposure of the stimulus a warning signal was given by a gentle tap on an electric hammer placed beneath the table at which the Subject was seated.

The psychogalvanic deflections were registered by means of a D'Arsonval galvanometer. There was an external current of 4 volts, shunted by an adjustable resistance so as to regulate the amount of current which should go through the coils of the instrument. Usually only one-tenth of the current was allowed to pass through the Subject, but when his sensitivity was low a smaller shunt of five, and occasionally of two, was used. The galvanometer was of the moving coil type with a sensitivity of 330 mm. per microampere at one meter scale distance. The resistance of the coil was 100 ohms. The period of deflection was from 4 to 5 seconds and the movement of the coil was well damped. A Wheatstone bridge was enclosed in an insulated box so that the only contact possible was through the Subject's electrodes. Arms 1 and 2 of the bridge had a fixed resistance of 1000 and 10,000 ohms respectively. Arm 3 was a variable resistance for balancing the whole bridge after the Subject was in the circuit. This was effected by means of movable dials which changed the resistance by 1000, 10,000 or 100,000 ohms,



as shown in the diagram. The electrodes were of brass 19 mm. in diameter and covered with chamois skin, which was kept well moistened with physiological salt solution. They were kept in place on the palm and back of the left hand by a broad, smooth band, by which the hand itself and arm were strapped motionless to a wooden splint. The hands were washed in warm water with soap before each sitting so as to make the skin resistance of each Subject as uniform as possible. The records were taken photographically: on the photograph of the psychogalvanic deflections the time was marked in seconds: a break in this time register showing the exact moment at which the stimulus was exposed.



The above are photographs of two typical curves. The time marks register seconds, and the break in the time record shows the moment of exposure. The downward curve is made by a fall in resistance. A is a simple curve with comparatively short latent period, rapid fall in resistance after the exposure of the stimulus, and a somewhat slower recovery. It is noticeable that the recovery is not quite complete—a very ordinary phenomenon. The tracing before the exposure of the stimulus shows the Subject's previous stable resistance. It was 15,000 ohms when the shunt was 10, in other words when one-tenth of the external current of 4 volts was passing through the closed circuit of the bridge.

The fall in resistance as shown by the photographed curve, is 690 ohms or 4.6 per cent of the previous resistance of the Subject.

B is a somewhat more complicated curve. It shows the usual latent period after the exposure of the stimulus, then a fall in resistance of 612 ohms (3.6 per cent of the Subject's initial resistance of 17,000 ohms). Then there is a gradual rise almost to the former level, then another fall greater than the first. Sometimes the curves are even more complex than this one. Sudden fluctuations of resistance are registered and often the introspections suggest "no explanation of them."

The Subject was alone in a room with closed doors, in which only the inside of the box and exposing apparatus were illuminated. The Experimenter was in an adjacent room, where the clock, the galvanometer, and photographing instruments were kept. He came to the Subject immediately after each reaction to take down the introspection. The Subjects were asked no questions which might influence them by suggestion; though, occasionally, they were urged to pay special attention to some

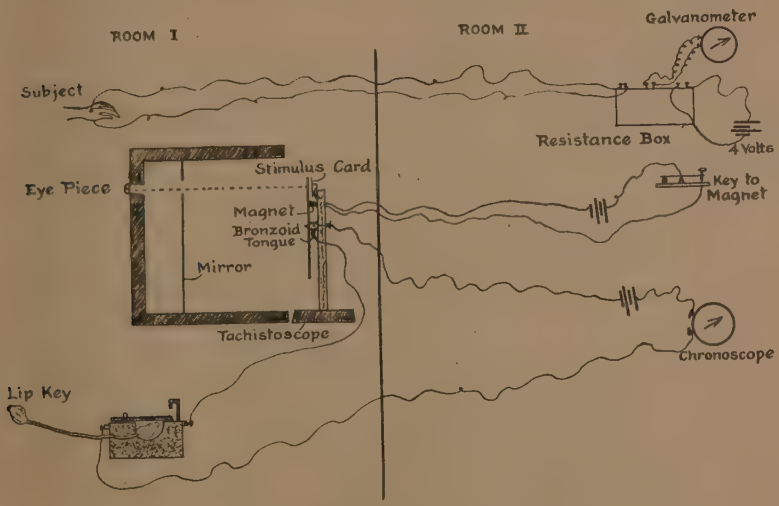


Diagram of Apparatus

particular phase of the process which they had observed but could not clearly describe.

The instructions were repeated before each set of experiments. With the exception of a few cases towards the end of a Subject's series, these instructions were always the same and as follows:

> "You will be shown a set of words in different colours. Respond to the colour. If the word is red, rhyme it. If it is green, reverse it. If black, change its vowel. If blue, you may rhyme or reverse as you choose. React as quickly as possible."

OBJECTIVE RESULTS

REACTION TIMES

THOUGH our Reaction Times do not yield the clear-cut, definite results we had hoped for, they furnish some instructive data. They show the well-known differences between individuals and between different tasks in the case of the same individual. In Table I are found the averages of the Reaction Times of the single Subjects for the various operations involved in the experiments. The figures in parentheses give the number of times each Subject performed the task in question.

TABLE I

(Reaction Times in σ for the various tasks.)

Subject	*Rhyme*	*Transposition*	*Change of Vowel*	*Choice*
A	2204 (34)	2161 (33)	1977 (35)	2433 (35)
B	2459 (33)	2170 (26)	2247 (31)	5446 (35)
C	1646 (35)	1602 (32)	1536 (31)	1939 (36)
D	3459 (47)	3134 (46)	3183 (47)	3965 (43)
E	1341 (38)	1249 (39)	1188 (38)	1615 (38)

On one task, the Choice, the Subject was at liberty to rhyme, or to transpose the consonants of the stimulus word. All the Subjects report this the most difficult response, and, without exception, the time for this reaction is the longest. B, who had independently been carrying out a protracted series of experiments on Choice, practically always got the two alternatives explicitly in consciousness, and then chose one of them, for some reasonable motive. The result appears in the exceptionally long reaction time for this task when compared with this Subject's other reactions.

D was almost scrupulously painstaking about carrying out the instructions, and more concerned with giving a correct response

than a speedy one. His reaction times are conspicuously longer than those of the other Subjects.

The task of transposing the first and last consonants was easier than finding a rhyme, and the former task was carried out more quickly than the latter. The difference of times for these two operations is pronounced, except in the case of C. The discrepancy in his case is explained by the nature of his response. In thirty-eight of the forty times he had to rhyme he gave his response by simply substituting an *s* for the initial letter of the stimulus, thus obviating the necessity of search for a rhyme.

Comparing the relative times for changing the vowel and transposing the consonants, we notice that B and D react more quickly when they transpose. With C and E the times for transposing exceed those for changing the vowel by only 66 and 61 sigma respectively. A's time is noticeably shorter in changing the vowel.

In the beginning of the experiments, the only stimuli used were the first syllables of the dissyllabic nonsense words which by a hundred and sixty repetitions had been learned with the intention of binding the first and second syllables together by a strong association. When, however, the initial syllables were exposed they scarcely ever evoked the companion syllables, and in the very few cases in which the associates did come up, they were too weak to affect the reaction. The Subject's introspection gave no evidence of a *struggle* between the tendency to respond with the associate and the fulfillment of the instruction. This state of affairs continued during the first stage of the experiments, during which each Subject performed the four tasks with all the ten stimuli. The method of procedure was then modified. We thought that if unlearned syllables were mixed with the learned ones, and exposed under identical conditions with the same instructions, the reactions to the learned and unlearned words might show instructive differences. If, for instance, the Reaction Times for the learned syllables were relatively longer we might have a clue to an inhibition, which, though not manifesting itself formally as a tendency to respond with the syllable associated with the stimulus, was, however, delaying the reaction. If such

an inhibition did appear, it seemed plausible to refer it to an unconscious inclination to give the associate syllable, because, so far as we had been able to regulate the conditions, the learned syllables differed from the unlearned only in the fact that the former had associates and the latter had none. Our expectations were only partially realized, but there were significant changes in the Reaction Times.

The following Table gives the average Reaction Times when (1) only learned syllables were used as stimuli, and (2) when both learned and unlearned stimuli were used. As before the figures in parentheses show the number of reactions.

TABLE II

(Comparative Reaction Times in σ for Mixed and Unmixed Series.)

Subject		*Rhyme*	*Transposition*	*Change of Vowel*	*Choice*
A	1.	1685 (8)	1958 (7)	1411 (8)	1913 (8)
	2.	2658 (17)	2351 (16)	2308 (18)	2950 (17)
B	1.	1894 (10)	1784 (6)	2519 (8)	5282 (7)
	2.	2729 (15)	2401 (14)	2251 (14)	5644 (14)
C	1.	1192 (6)	1021 (6)	835 (5)	1230 (6)
	2.	1740 (29)	1735 (26)	1670 (26)	2080 (30)
D	1.	3600 (12)	3884 (11)	3018 (10)	4575 (9)
	2.	5336 (15)	4649 (15)	4872 (17)	5641 (16)
E	1.	1514 (9)	1369 (10)	1147 (9)	1689 (10)
	2.	1327 (19)	1216 (19)	1293 (20)	1599 (18)

It is evident from the above Table that, with the same tasks, the Reaction Times are longer when the Subjects are responding to "mixed sets," i. e., sets made up of four old syllables and four new ones, than when they are responding to unmixed sets, composed only of the syllables they had learned by frequent repetitions. Our protocols give a satisfactory explanation of this phenomenon. The instructions were simply to respond to the coloured stimulus word, rhyming it if it were red, transposing its consonants if it were green, etc. But, on the introduction of the unlearned syllables, four of the subjects spontaneously assumed the task of satisfying themselves as to whether the

exposed word was old or new. This gratuitous operation consumed time in itself, and besides, it impeded the desired reaction of the experiments, since, after the process of identification of the syllable, the Subject had to recall his attention to the specific task to be executed. D's normal Reaction Times are long, and when he took on himself the new task of recognizing the syllable he increased them proportionately. The increase is more pronounced with D than with A, B, or C. Their method of identification was more expeditious; they referred the stimulus to the associate; in other words, if the exposed syllable evoked an associate in consciousness, the stimulus syllable was recognized as old, otherwise it was new. But D made his recognition dependent on the memory image he had of the list of learned words; if the stimulus fitted into the list, it was old; if it did not, it was new. This obviously was a more laborious and lengthy manner of procedure.

E's Reaction Times are *shorter* in the mixed sets than they were when only learned syllables were used. He did not trouble to see whether the stimuli in the mixed sets were old or new. For him they were simply coloured syllables to which he was to react as instructed. And since he was more practised in the mixed set—having already reacted forty times to the learned syllables—his reactions for this set are shorter. The only exception is on the task of changing the vowel, and the protracted time here is owing to one exceptionally long reaction, due to a bad adaptation.

As noted above, the purpose of introducing the unlearned syllables into the experiments was an endeavour to ascertain if the associates of the learned syllables were inhibiting the response. We thought that if the Reaction Times on the old syllables were longer than on the new, we could attribute the fact to the influence of the associate, since the conditions of presentation and the manner of reaction were the same for both. It may be objected that the unfamiliarity of the new syllables would draw out their reaction times and so counterbalance any increase the associate might effect in the case of the old ones. This objection has some weight. But, in reality, the new syllables

were not much more unfamiliar than the old ones were when these latter were first exposed to the Subject, i. e., in the previous set of forty reactions when only learned syllables were used as stimuli. The reason is this. When the Subject learned the nonsense words originally, he learned them as two-syllable words, and from a list printed in small black letters. When, however, they were shown to him as stimuli, it was a single syllable of the whole word he had learned, that he perceived; it was by itself, and not in a list; and it was printed in large, coloured letters. Therefore it, too, was unfamiliar, perhaps as much so as the new monosyllable which was later introduced.

To evaluate the results, we must compare the relative Reaction Times for the learned and unlearned syllables in respect to each other. This we have done in two ways: viz., by comparing the Times of (1), the set of reactions in which both learned and unlearned syllables were used as stimuli; and (2), the reactions in the two sets in which the stimuli were learned and unlearned syllables, respectively. The following Table (III) contains the averages for the "mixed sets." The first row of figures gives the Reaction Times of the learned, the second of the unlearned syllables.

TABLE III

(Reaction Times in σ for Mixed Series.)

	Rhyme	*Transposition*	*Change of Vowel*	*Choice*
Learned	2696 (48)	2201 (47)	2182 (45)	3096 (51)
Unlearned	2431 (47)	2203 (43)	2489 (51)	3461 (44)

Note—The above averages are for only four Subjects. The method of procedure was varied with C, and his reactions, therefore, cannot be compared with those of the other Subjects.

For the task of transposing the consonants the Reaction Times are the same with both learned and unlearned syllables.

When the response is made by changing the vowel, or is left to the Subject's choice, the time is longer for the unlearned syllables. The only task for which the unlearned material is not longer is that of rhyming. The high average for the learned syllables in this case is due to the reactions of one Subject, B;

the other three Subjects' time for rhyming is longer for the unlearned syllables.

So far, therefore, as Reaction Times are concerned, there is no evidence of an inhibition effected by the associate.

The learned syllables of this "mixed set" had each been seen four times before, namely, in the previous set of forty reactions, in which only learned syllables had been used as stimuli. Therefore they were more familiar than the new, unlearned syllables, and this fact may explain some of the difference of Reaction Time,[1] but it does not explain all.[2] For after this "mixed set," the Subjects were given another set of forty expositions in which the stimuli were the unlearned syllables previously used. In Table IV are shown the Reaction Times when the stimuli were (1), only learned, and (2), only unlearned syllables. Each set consisted of forty reactions. The Subjects are the four whose averages are shown in Table III.

TABLE IV

(Reaction Times in σ for series where only Learned or only Unlearned stimuli were used.)

	Rhyme	*Transposition*	*Change of Vowel*	*Choice*
Learned	1742	1613	1623	2475
Unlearned	1935	1688	1753	2823

[1] We have said above that learned and unlearned syllables were equally unfamiliar when they were shown the *first* time. Here we are speaking of the *second* series of reactions, when the stimuli are both learned and unlearned syllables. In this series the unlearned syllables were seen for the first time. They are, therefore, relatively less familiar than the learned syllables, which are being repeated after one complete set of exposures—i. e., each learned syllable has already been shown four times, once in each colour.

[2] New words were distinguished as such by the fact that they had no associates as the old ones had. We may presume the process of waiting in vain for the appearance of an associate was—other things being equal—more lengthy than the recall of an actual associate. This remark applies especially to the Reaction Times of A and B, which are included in Table III.

The order of presentations had been:

1) 40 exposures in which the stimuli were the learned syllables.
2) 80 exposures with both learned and unlearned syllables.
3) 40 exposures when only unlearned syllables were used.

The Reaction Times in Table IV are for the first and third of these sets.[3] During the third set the Subject had had more practice in carrying out the instructions than he had during the first. The stimuli of the third set were comparatively familiar, since they had been seen previously in the second mixed set. On the other hand, the stimuli of the first set, though they were the initial syllables of the learned nonsense words, were unfamiliar, having never been seen in the form in which they were now exposed. *A priori*, we should expect the Reaction Times of the first set—i. e., of the learned syllables—to be longer, especially if the associate were inhibiting the response. They are noticeably shorter. Therefore, it is plain from Tables III and IV that whether learned syllables are exposed independently of, or in conjunction with, unlearned syllables, these latter have the longer Reaction Time.

Hence, we conclude that the associates to the learned stimuli exerted no influence on the reaction. In other words, the Subject was not retarded in carrying out the instructions of our experiments by a tendency to react with the syllable he had strongly associated with the stimulus. And this conclusion, based on the objective data of the Reaction Times, is corroborated by the subjective reports in our protocols.

It may be objected that our Reaction Times are unusually long; and that, had our Subjects reacted as quickly as Ach's did, we, too, should have had associates cropping up into consciousness, and even spoken as responses. To this we answer that

[3] The Reaction Times in this Table are significantly shorter than those in Table III, the reason being that the averages in Table III are for experiments in which the stimuli were made up of old and new syllables. In these circumstances the process of *identification* lengthened the times. The averages in Table IV are for reactions to unmixed stimuli, only learned or only unlearned syllables. In such conditions there was no hold up because of identification. The Subject knew beforehand whether the stimulus was old or not.

though, as a general rule, our reactions are longer than those in Ach's experiments, they are not always so. Many of his Subjects gave times as long or longer than those of our Subjects E and C. Moreover, a long Reaction Time would not in itself have any bearing on the emergence of the associate, for if the companion syllable of the stimulus comes up through the influence of association, it may be argued that it would come in the very beginning—immediately upon the perception of the stimulus with which it is associated. The time added on to the reaction after that, would not affect its appearance. Long reactions, therefore, could be said to influence the appearance of the associate only in so far as they are registered in the performance of a task unfavourable to its emergence, or in so far as they indicate a state of mind, which, while repressing the associate, lengthens out the Reaction Time. It is true that there is another possible explanation of long Reaction Times, namely, that the associate exercises an unconscious inhibition which hampers the reaction that the Subject is instructed to make. But we have dealt with this supposition above, where we argued, from the figures contained in the Tables, that there is no such unconscious inhibition, at least so far as the Reaction Times show.

We feel quite sure that in our experiments the same cause operated to suppress the associate, and when they are so lengthened, to lengthen out the Reaction Times beyond those of Ach. We shall show later how the nature of the tasks in our experiments precluded the spontaneous appearance of the associate (cf. p. 75 sqq.). Here we confine ourselves to a consideration of how it drew out the Reaction Times.

Ach himself found that, as a general rule, a Subject took a longer time for reaction when he gave an optional response to the stimulus than when he responded to it according to instrutions which specified what he was to do. If he reacted to the nonsense syllable by rhyming it or by transposing its consonants, the task was easier than if he responded with *any* nonsense syllable; and the Reaction Times show that it was more quickly carried out. Ach embodies these phenomena in his Law of Special Determination: "The more specialized the determination,

the faster and surer is its fulfillment." His students have corroborated this Law. Selz, on the contrary, declares it improbable that the specialized, but more difficult, operation should be more quickly executed than an easier general one.[4] It certainly seems that, in this matter, the nature of the task must be reckoned with. If a Subject knows beforehand that he must respond to a stimulus by giving a rhyme to it or by transposing its consonants, the material with which he has to work is practically prepared for him; but if he is to respond with any nonsense syllable, he must first *find* a definite response before he can give it. It is not strange, therefore, that in the former case the reaction is very much shorter. When there is question of transposing the consonants of the stimulus, he simply fixates the last of them and carries out his task. This was the normal process with our Subjects, as soon as they recognised that their task was to transpose. In the case of rhyming the stimulus, the process may become still more simple. The Subject may, unconsciously, have an initial letter prepared to substitute in the place of the first letter of the stimulus. This might be owing to Perseveration as could easily happen in the conditions of Ach's experiments; or to an unconscious "set," as happened regularly in our own. For instance, C, the most outstanding example of such a "set," was given the task of rhyming the stimulus forty-one times, and out of forty correct responses thirty-eight began with *s*. All the other Subjects show a like tendency, though none so pronounced as C; and they report frequently that they were held up, because they were inclined to begin their rhyme with a letter which they had observed they were tempted to give habitually.

Ach argued that the speed and sureness of the reaction were proportional to the strength of the determination. His thesis is that the stronger the determining tendency was, the less chance the associative tendency had to manifest itself. Therefore, by implication, the quicker and surer the reaction, the less chance the associate had of appearing.[5] Without straining the argument,

[4] Die experimentelle Untersuchung des Willensaktes. O. Selz, p. 261 in the *Zeitschrift für Psychologie*, Vol. LVII, 1911, pp. 241-270.

[5] We may put the argument in syllogistic form, as follows: The

we might infer that our longer reactions would have *favoured* the emergence of the associate. But we do not stress this point. What we wish to emphasize is this: both the length of Reaction Times and the failure of the associates to come up, are due to the same cause—the nature of the task. The Reaction Times are longer because our reactions were more complex than Ach's and entailed more numerous mental operations. Secondly, they were longer because our Subjects could not speed up the reaction as Ach's Subjects did, since they did not know what they were to do with the stimulus before it appeared, and were unable to be "set" to make the necessary changes.

The associate failed to appear because our Subjects' primary attention was given not to the word with which the associate was linked, but to the colour which had no relation to the associate. We treat this phase of the matter in another part of the work.[a]

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stronger the determining tendency the quicker the reaction. The stronger the determining tendency the less chance the associate has to emerge. Hence, the quicker the reaction the less chance the associate had to emerge.

[a] cf. p. 76.

THE PSYCHOGALVANIC REFLEX

THE physiological changes responsible for psychogalvanic deflections are not conclusively known. Sommer's contention that the phenomenon is a physical change due to differences of pressure on the electrodes, is almost universally rejected. Sidis and Kalmus conclude, from an elaborate series of experiments, that "active physiological, sensory, and emotional processes, with the exception of pure ideational ones, initiated in a living organism, bring about electromotive forces with consequent galvanometric deflections." [1] It is generally disputed, however, that the deflections are produced by changes in the electromotive force, at least in experiments carried out, as ours were, by the passage of an electric current through the body.[2] On the contrary, the general belief is that they are due to a fall in bodily resistance; though in explaining the precise cause of this fall, investigators differ widely. Vigoroux maintains that it is due to variations in the capillary blood-flow, as a result of the emotions. Stricker holds that the deflections are caused by circulatory changes induced by mental states. Tarchonov claims that secretory changes in the skin are responsible for the fall in resistance. This last view has come to be widely accepted; and the secretory changes in question are usually associated with the sweat glands. This,

[1] A Study of Galvanometric Deflections Due to Psycho-physiological Processes, by Boris Sidis, Ph. D., M. D., and H. T. Kalmus, Ph. D.—*Psych. Rev.*, 1908, Vol. XV, and 1909, Vol. XVI.

[2] Thouless maintains that changes in the electromotive force, in polarization, and in the bodily resistance, all enter into the production of the curve. He claims, however, that the change in polarization and the amount of electromotive force produced are so small compared to the changes in bodily resistance, that they are negligible. This is especially true in the case of the electromotive force when an external current is made to pass through the Subject. These conclusions were set forth in a paper communicated to the British Psychological Society on March 21, 1925, by Mr. Thouless, M. A., of Manchester University.

however, is only theory and lacks the confirmation of exact experimental evidence.[3]

The lack of unanimity among those who have investigated the physiological causes of the reflex is, necessarily, a cause of regret and difficulty to the psychologist. It is true, he is interested in the psychogalvanic curve from a different angle than the physiologist. The psychologist's concern is not so much with physical changes in the organism, as with the mental antecedents, or accompaniments, or consequents of those changes. Hence it is, that he is justified in his endeavour to explain the curve from his own point of view, in spite of the uncertainty surrounding its physiological production. He may prescind from the precise physiological causes of the deflections. He may take his curve as he finds it, study it from his particular angle, and attempt to interpret and correlate it with the introspective data of his protocols. Undoubtedly, if he had at his disposal more definite physiological knowledge than is available at present, his task would be vastly simplified; but it would not be solved. There is more than physiology involved. Of course, the curve registered by the instrument is physiological in its immediate origin. It is directly caused by organic changes in the Subject; but these in turn, at least in experiments like ours, are excited by mental states, which, therefore, are the ultimate causes of the reflex. These states, as such, do not enter into the purview of the physiologist; it is for the psychologist to study them. This is his point of view with respect to the reflex. His aim must be to answer the question: "What are the mental states which excite the deflection or influence its variations?" A variety of responses have been given to this query.

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[3] In fact there is experimental evidence against such a theory. In the physiological laboratory of Kings College, we obtained psychogalvanic deflections from anaesthetized cats when the electrodes were placed on the subcutaneous tissues, when they were put directly on the naked muscles of the thighs, and also when needle electrodes were deeply inserted into the muscles. In none of these cases could the sweat glands affect the reactions. These results are to be published by Professor R. J. S. McDowall, in the *Proc. of the Royal Soc.* The paper is still in the press (April, 1925).

Radecki,[4] Sidis and Kalmus,[5] Binswanger,[6] and many others hold that such states are *exclusively* emotional or affective. Peterson and Jung,[7] Veraguth,[8] Starch,[9] Gregor and Gorn,[1] Abbott and Wells,[2] and others, maintain that all mental effort produces some slight deflection.

Prideaux [3] grants that purely mental activities cause some deflection, but this is so small that it can be practically neglected for the purely emotional.

Wells says: "We may formulate the hypothesis that the occurrence of the reflex, whatever it may signify with regard to physiological change, is regularly preceded by changes in consciousness of a conative rather than an emotional character.[4]

In the circumstances such discrepancy of opinion is not strange. The number of variable factors entering into the production of the reflex is, undoubtedly, very large. The psychogalvanic curve is probably an "average curve"—the algebraic sum of several curves—differing in their respective causes; but fused together, partly because they are imperfectly synchronous, partly, also,

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[4] Radecki, W. "Recherches expérimentales sur les phénomènes psycho-electriques." *Arch. de Psychologie,* 1911, XI.

[5] Sidis, Boris, Ph. D., M. D., and Kalmus, H. T., Ph. D. "A Study of Galvanometric Deflections Due to Psycho-physiological Processes." *Psych. Rev.,* 1908, Vol. XV, and 1909, Vol. XVI.

[6] Binswanger, L. "Über das Verhalten des psychogalv. Phänomens beim Assoziations experiment." *Jour. f. Psychol. u. Neurol.,* 1908, Bd. X, S. 149.

[7] Peterson, F. and Jung, C. G. "Psycho-physical Investigations with the Galvanometer and Pneumograph." *Brain,* 1907, Vol. XXX, pp. 153-218.

[8] Veraguth, O. "Das psychogalvanische Reflexphänomen." Berlin, 1909.

[9] Starch, D. "Mental Processes and Concomitant Galvanometric Changes." *Psych. Rev.,* 1910, Vol. XVII.

[1] Gregor, A. and Gorn, W. "Zur psychopathologischen und klinischen Bedeutung des psychogalvanische Phänomens." *Zeit. f. d. ges. Neurol. u. Psychiat.* 1913, Bd. XVI.

[2] Abbott, E. S. and Wells, F. L. "Psychogalvanism in the Observation of Stuporose Conditions." *Psych. Rev.,* 1919, Vol. XXVI.

[3] Prideaux, E. "The Psychogalvanic Reflex—A Review." *Brain,* Vol. XLIII, Part I, 1920.

[4] Wells, Honoria M. "A Note on the Psychological Significance of the Psychogalvanic Reaction." *Brit. J. of Psych.,* 1924, Vol. XIV.

owing to the inertia of the apparatus.[5] It is by untangling this complex, by segregating the individual components of the registered curve, that the physiologist will do a good service to psychology.

It is easy to show that "emotional" stimuli—and in particular, nocive stimuli—always cause large deflections. It does not follow that deflections are produced by no other kind. As a matter of fact, well marked reflexes are observed when the stimuli are not emotional objectively, when no introspections of subjective emotion are reported, and when the Subject is conscious only of conative impulses. Since this is so, it follows, that from a psychological point of view—in other words, regarded as a phenomenon accompanying conscious processes—the psychogalvanic reflex is excited by other causes than emotion and affection, or by a cause of which emotion may be the concomitant or the effect.

Before enumerating the results we have obtained, it may be well to remark that in our experiments the stimuli had no marked intrinsic emotional values. They were simply coloured syllables, instructing the Subject to perform certain tasks, which for the most part were emotionally indifferent. Whatever emotional states occurred were mainly due to excitations extraneous to the experiments themselves, or to difficulties in carrying out the instructions. Only in the case of one Subject was the perception of the stimulus tinged with affective tone. The task of *changing the vowel* of the exposed word was indicated by showing the word in black letters. The Subject in question was influenced by the black colour. He perceived the black as,

"menacing,"
"distinctly unpleasant,"
"threatening,"

[5] "The experiments up to date can be explained as showing that mental activity is accompanied by muscular activity and by variations in animal secretions," Dunlap, K. "Galvanometric Deflections with Electrodes Applied to the Animal Body," *Psych. Bulletin,* Vol. VII, 1910, p. 175. And Piéron writes: "Il n'y a là q'une méthode d'appoint particulièrement délicate dane la pratique, extrêmement dangereuse dans l'interprétation, et difficilement utilisable la plupart du temps en médicine mentale." "La reflexe psychogalvanique." *Rev. de Psychiat.,* 1910, 14. p. 478.

and so on.[6] This particular task of changing the vowel was the easiest of all, according to the Subject's own report. His Reaction Time for it was the shortest; but his average deflection for it is higher than for any other reaction.

The latent period for the reflex varies with different Subjects and in the same Subject under different conditions. It is commonly thought that the latent period for a real reflex with the psychogalvanometer, when a mirror galvanometer is used, is two or three seconds. We disregard the consideration of the deflections which have longer latent periods than this; and hence not all the deflections we obtained during the course of our experiments are found in the following tables.[7]

The figures given in the following Tables always indicate the average percentage drop in resistance. The Subject was "balanced" before each reaction and this initial resistance noted; his fall in resistance during the reaction was photographed.

The photographed curve was first measured in millimeters, then converted into ohms by means of a standard table. There was a uniform, gradual drop in a Subject's resistance during the course of a single day's experiment. He would begin, for instance, with a resistance of 30,000 ohms, and at the end of the half hour or forty-five minutes during which a day's reactions lasted, he would be down to 10,000.[8] A fall of 1000 ohms on

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[6] But this Subject explains the terms used as expressive of conative rather than affective experience.

[7] We found that when the time registered by the clock was added to a Subject's latent period, and then measured off from the point on the curve at which the stimulus had been exposed, there was a fairly accurate coincidence with the lowest point of a deflection. This sometimes served us as a guide in determining the deflection of the reaction produced by the syllable exposed, and this was useful, when, as happened not infrequently, more than one fall of resistance is registered on the photograph.

[8] This diurnal change may be in part due to the falls in resistance consequent upon the stimuli. Though the Subject's resistance rises after a reaction, it often does not attain to its previous level. The summation of those partial failures of recovery may account for some of the decrease of resistance during a sitting. But here we are more concerned with the fact than with its explanation. The point we wish to note is that absolute falls of resistance are not accurate expressions of the amount of the reflex.

the first reaction of the day had a different value, therefore, than did the same fall on the last reaction since the change from 30,000 to 29,000 ohms is relatively smaller than that between 10,000 and 9000 ohms. So for purposes of comparison we measure our curves in percentages: a fall of 1000 ohms on an initial resistance of 10,000, has the same relative value as one of 3000 ohms when the Subject's resistance was 30,000, the moment the stimulus was exposed. The changes in both cases are ten per cent. The figures in the following Tables are averages of such percentage changes in resistance.

The following Table gives percentage falls in resistance for a series of 697 curves.

TABLE V

Report of	*No. of Cases*	*Average Per Cent Fall in Resistance*
1. Only affective tone	179	2.82
2. No affective tone	345	1.37
3. Only conative tendencies	89	1.40
4. Both conative tendencies and affective tone	66	3.20

The affective tone was reported in various ways: as feelings of "astonishment," "surprise," "satisfaction," "relief," "relaxation," "consternation," bewilderment," "pleasure," "displeasure," "confusion," "strain," "excitement," "agitation," "helplessness," "annoyance," "amusement," etc.

When the Subject was badly adapted for the experiment—not well adjusted when the stimulus appeared, taken by surprise by the unexpectedness of the warning signal, distracted by extraneous noises, or shown the stimulus without the customary warning—there are, regularly, deflections greater than the Subject's average. If an affective element (such as one of those enumerated above) intervenes before the exposure of the stimulus word, the latent period of the reaction curve is shorter than the Subject's normal.

The method of presentation of the stimuli was such that the deflections may be grouped into three classes. The Subject was first shown a set of reaction words made up of the first syllables

of the ten dissyllabic nonsense words he had learned by a large number of repetitions. Each syllable was shown four times; in other words, with each syllable the Subject performed the tasks of rhyming the stimulus, transposing its initial and final consonants, changing its vowel, or rhyming or transposing as he himself chose. The averages for this set are marked I in the following Table VI.

The second group of experiments (the averages for which are in the lines 2 of the Table), consisted of eighty reactions for each Subject. There were twenty stimulus-syllables; the ten used in the set described above, and ten new monosyllabic nonsense-syllables which the Subject had never seen before. Each day four of the old and four new syllables were exposed, under identical conditions and with the same instructions (as set out above).

The third set of experiments (3 in the Table), was made up of forty reactions. The stimuli were the ten new nonsense-syllables used in Set 2. The task was the same.

The Table gives average percentage falls in resistance for five Subjects and a total of 734 tasks.

TABLE VI

Subject		*Rhyme*	*Transposition*	*Change of Vowel*	*Choice*
A	1.	4.66	4.63	5.28	4.32
	2.	2.63	2.92	2.98	3.09
	3.	1.59	1.68	1.92	1.37
B	1.	2.23	2.55	2.81	3.72
	2.	1.89	1.65	1.48	1.12
	3.	0.47	0.90	1.79[9]	1.09
D	1.	5.66	4.57	7.55	5.40
	2.	3.84	5.11	3.97	5.66
	3.	4.04[9]	4.75	4.94	5.07
E	1.	3.33	4.55	3.94	3.97
	2.	3.58[9]	3.21	3.15	3.39
	3.	2.13	2.67	1.74	1.36
C	1.	1.04	1.78	0.91	0.90
	2.	0.61[1]	0.80	0.63	0.78

It is plain from the above Table that there is a regular decrease in the size of the deflections as the experiments proceeded. This may be partly owing to the fact that the tasks were becoming easier by repetition. But the tasks embraced in Group 2 were more complicated, and from that aspect, theoretically more difficult, than those in Group 1. Therefore some other factor besides ease of accomplishment must intervene. We think it is an emotional one.[2] As the Subject proceeded with the experiments,

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[1] B shows a uniform decrease in the size of deflection as the tasks proceeded, except in the case of changing the vowel in the last (third) set of experiments. This discrepancy is due to one exceptionally large deflection. In this reaction there was a fall of 7.10 per cent of the Subject's initial resistance. The introspection suggests no explanation of it. If this one very large deflection is disregarded, B's average fall in resistance for the task of changing the vowel in the third series of reactions (10) becomes 1.13 per cent instead of 1.79 per cent, and this Subject's average deflection for the three series with the task of changing the vowel then reads: 1) 2.81 per cent; 2) 1.48 per cent; 3) 1.13 per cent; thus showing an unbroken decrease of deflection as the experiments proceeded.

D was urged to react more quickly in his third series (3). His effort to do so may explain his high average for deflections in this set.

E's deflections for the task of rhyming show a higher average drop in the second series (2) than in the first (1). This is likewise due to two exceptionally large deflections of 7.4 per cent and 7.3 per cent of the initial resistance. In both cases the Subject was badly adapted to the experiment (he was accidentally disturbed by events extraneous to the experiment). Abstracting from these two abnormally great reflexes, E's average for the task of rhyming in the second series (18 reactions) would be 3.16 per cent. His average deflections for the three tasks of rhyming then become: 1) 3.33 per cent; 2) 3.16 per cent; 3) 2.13 per cent.

[1] The order of presentations for Subject C differed from that of the other Subjects. He was first given a set of 115 reactions with syllables he had learned and others he had not seen. The averages for these are in 1. In 2 are averages for 25 reactions with syllables he has learned by 160 repetitions.

[2] It has been copiously disputed whether Aristotle's original division of mental processes into 1) cognitive, and 2) orectic, is comprehensive. (Arist. de Anima, ii). This division was accepted generally by the Scholastics and is held by many philosophers today. Among modern writers Reid and Stewart contended for a two-fold division of the contents of consciousness and made a distribution into *Intellectual and Active* powers, thereby admitting no distinction between perceptual and conceptual knowledge and denying that cognition is active. Hamilton adopted a three-fold division into 1) Knowledge, 2) Feeling, and 3)

his confidence was inspired by his previous correct responses; his attention towards the approaching stimulus was less excited and nervous, and he was not so affected by the appearance of the stimulus, as is plain from the introspections. The supposition that the deflections decreased with decreasing emotion seems confirmed by this further fact: when a subject has

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Conation; a distribution which was popularized by Kant. All these three are held to be ultimately distinct forms of conscious activity, and none of them is identical with or resolvable into the other two.

Such discrepancy of opinions has generated a corresponding ambiguity of terms; so that "Feeling," "Emotion," and "Conation," have come to be used in a variety of widely different meanings. For a proper understanding of the theory we advance in respect to the psychogalvanic reflex, we deem it necessary to explain our conception of the meaning of these terms. By way of preface we may remark that here we deal only with what James calls "the coarser emotions," and prescind from those pathological states in which the emotion is objectless.

We conceive the genesis of an emotional state to be as follows. An object, or stimulus, is perceived and cognized as desirable or undesirable to him who perceives it. Consequent upon this perception there is an appetitive disposition aroused in the reagent, either towards the object or away from it. This is conative. This appetitive disposition (or conation) excites organic changes which are chiefly visceral, though they may overflow into the voluntary musculature. It is a complex, a "cognition" and a resultant appetency with consequent organic changes translated into consciousness, which constitutes the emotion. All the above elements are not present to consciousness with equal vividness; in fact, in an affection, and *a fortiori* in an emotion it is the consciousness related to the physiological disturbances which predominates. At times it does so so completely that the other two elements are excluded from the field of awareness. Therefore, the somatic resonance is the immediate cause of the emotion; but it is not the only cause or the primary one. For no stimulus has an affective value for me unless I cognize it as desirable or aversive, and, indeed, desirable or aversive to me. In a normal individual an affective state includes cognition and appetition (Conation) as essential elements; but a true psychological emotion obtains only when these arouse *conscious* organic changes. If from the "coarser emotions," we abstract this feeling, they lose an essential constituent; but they do not become "purely cognitive in form, pale, colouriess . . ." as James maintains. (Cf. Princ. of Psych., Vol. I, p. 450.) The element of *appetition* (*conation*) still remains. We might add that the only sense in which an object can be said to have an emotional value *in itself*, is when it arouses an emotional state in the majority of those who perceive it. The bright, red coal which the child desires to play with becomes a fearsome object after he has been burned. The coal undergoes no objective change; the child's subjective attitude does.

become accustomed to a certain kind of response, for example, reacting to the *colour*, by rhyming all red, transposing all green, stimuli, etc., and then is put to doing a different task, let us say rhyming everything shown him, regardless of its colour, there is a brief flare-up of activity. The deflections for the first few reactions are noticeably larger than they have been running. After a very few successful responses, however, the deflections sink back to the ordinary size. The introspections show that the Subject quickly adjusts himself to the changed conditions and after a few reactions, performs the new task with little or no emotional excitement.

Usually there is a gradual diurnal decrease in the reflex, also, but this is difficult of interpretation, since it is made irregular by any little emotional strain the subject may undergo.

We attribute the decrease in the deflections to a dying down of excitement. In so far as this latter is emotional, we are in agreement with the majority of those who have studied the reflex; and our interpretation is only a refinement of the well known fact of every day life, that familiarity diminishes excitement and nervousness in the most complicated and thrilling of tasks.

So far, we have been dealing with deflections which occurred when emotion was consciously present, or inferred from the objective data. There are often well marked deflections when the Subject is not conscious of emotions at all. This is especially true in reactions where conscious conative activity predominates. The outstanding phenomena in such reactions were reported as:

"consciousness of action,"
"mental activity,"
"active searching for a response,"
"pulses of activity,"
"striving,"
"mental action,"
"definite rejection of the alternative,"
"pronounced effort in getting response," etc.,

all of which are terms expressing conative activity. At times there are introspections which would seem positively to exclude any emotion, as the following:

"the reaction was quite active, but very cold";
(Fall of 1.8 per cent.)
"a lot of activity, but very calm";
(Fall of 0.9 per cent)
"some striving, but whole reaction was very deliberate."
(Fall of 0.9 per cent)[3]

There were eighty-nine cases in which conscious conative activity manifested itself, with no conscious emotion. The average fall in resistance for these cases was 1.4 per cent.

This offers us a possible basis of interpretation for another class of curves, viz., those of reactions, the introspections of which give no hint of emotion and no *formal* report of conscious conative activity. We have 256 such curves, with an average fall in resistance of 1.45 per cent. For some of these cases we are justified in presuming the presence of conation, though it is not explicitly reported; for when the Subject speaks of "inhibitions" impeding the task, or of "difficulty in carrying through the operation," he implicitly declares that he had to *strive* to reach his ultimately successful reaction. On the other hand, some of the deflections of this class occur in reactions where the introspections give us no clue to conscious conation, but report that the operation was

"very automatic,"
"easy,"
"quite mechanical,"
"with no effort,"
"very habitual," etc.

The reaction seemed "to take care of itself" in such cases, and required no conscious directive or motive force on the part of the Subject.

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[3] In themselves these figures are not imposing, but in their context they are significant. The first (1.8 per cent), is from a reaction of A, on a day when his deflections were smaller than was usual with this Subject. His average deflections on that day were only 1.7 per cent of his "stable" resistance. The other two figures, both 0.9 per cent, are from the same Subject, C. His normal reflex is small. His average for 140 reactions, which include those in which he was taken by "surprise," "startled," "astounded," etc., is just a little less than 1 per cent. For him, therefore, 0.9 per cent is a relatively large deflection.

We have one further group of deflections (cf. Table V, p. 34), viz., those in which both conative activity and emotion are reported. There are sixty-six of this kind in our protocols, with an average deflection of 3.20 per cent—higher by 13 per cent than the average deflection when emotion, but no conation is introspected.

Therefore, classified according to what is reported in the introspections, our deflections fall into four groups:

1. Those in which emotion is conspicuous in consciousness.
2. Those in which conation is reported, but no conscious emotion.
3. Those when both emotion and conation were consciously present.
4. Those "automatic" reactions in which the Subject was conscious neither of emotion nor conation.

In all the above groups we have psychogalvanic deflections, most pronounced when emotion is reported, but conspicuous also when it is not. In an effort to explain this phenomenon, we submit the theory that a psychogalvanic reflex is obtained whenever a Subject undergoes physiological changes of that essential kind which, when they have their repercussion in consciousness, constitute the formal element of emotion. Sometimes such organic changes have their conscious parallel; and in those conditions we may say that the psychological concomitant of the deflection is emotion. At other times the Subject is unconscious of any mental correlate of the physiological disturbances; and, therefore the resulting reflex cannot be concomitant to emotion, since consciousness of the "somatic resonance" is an essential constituent of this: without such consciousness there is no emotion. In other words, we discriminate between the physiological causes and psychological concomitants of the reflex. The former are physical changes in the organism—chiefly of the involuntary musculature and autonomic nervous system—aroused by dynamic mental states and activities. These latter are the psychological causes of the deflection and they are precisely the

dynamic states in question which may or may not be, or become, of an emotional character.[4]

We base our theory on the results of our experments and on analogies from ordinary life. For the sake of clearness we shall consider the different groups of deflections individually.

1. *Deflections when only emotion is reported.*

The average fall in resistance for this group is 2.8 per cent. We have already called attention to the regular decrease in deflection observable in the case of every Subject as he proceeded with his reactions, and have attributed the dying down of the reflex to the fact that he was becoming familiar with his task. At first he was vividly conscious of various organic tensions, both in the foreperiod and during the reaction itself; but he gradually became habituated to the warning signal, to the sudden appearance of the stimulus, and its equally sudden disappearance, to the quick recognition of his task, and the smooth performance of it. He felt the assurance that came from repeated successful reactions; and so his general attitude became easier as the series progressed. From being the inexperienced motor-driver, taut and strained and fearful of a mistake, or a sudden emergency, he became the confident expert who takes the present almost automatically and has no worries about the future. He was acquiring a habit—lessening his conative drain. The result was a progressive lessening of physiological tension during the reaction. Therefore, consciously there was less emotion, and the psychogalvanometer showed smaller deflections. Occasionally, however, something broke in on the routine to which the Subject was

[4] We may symbolize our conception in the following way:

As explained above (p. 37, note), perception arouses appetition (conation). Conation excites bodily changes—these are *always* registered by the psychogalvanometer. *Sometimes* they appear in consciousness as an emotion. In this assumption, there is never wanting a deflection when there is a conscious emotion, but there may be deflections with no trace of conscious emotion.

growing accustomed, something which startled him by its unexpectedness. Perhaps the warning signal sounded twice instead of once, or the signal may not have sounded at all and the wheel flashed by, thus exposing the stimulus before he was set to recognize it clearly. It may have been that a door banged in the gallery as he waited expectantly for the exposure, or that some other accident occurred to disturb his equilibrium. In all such cases the Subject was conscious of emotional states and the deflections were greater than the normal. On a small scale, he experienced the same organic tensions which are exaggerated when a person is confronted by an unexpected and startling situation which he must deal with in daily life. He grows pale, feels as though he were choking, or that "the bottom of his stomach has dropped out"; he may even faint. Such sensations are not essentially different from, rather they are an accentuation of, the organic changes our Subjects experienced in the reactions when they reported emotion in their introspections. They are the same as always predominate in emotional states. Hence we conclude that the deflections are physiologically due to such somatic tensions.[5]

2. *Deflections when only conative activity is reported.*

Reflexes of this class show an average drop in resistance of 1.4 per cent. Our theory supposes that all deflections are due to organic changes of the kind outlined above; and therefore we presume that such changes were present even when they are not reported as emotions by the Subject in his introspections. The failure to observe them may be due to one of two causes: either they were 1), subliminal, or 2), the Subject's attention was preoccupied with some other content of consciousness while they were marginal. It is a well known fact that the Subject's attitude

[5] We do not venture an opinion as to whether such organic changes produce a change in skin resistance or in E. M. F. Physiologically they might do either or both, reflexly. Normally, however, the Subject would not be conscious of either change, and so, since we are concerning ourselves with the psychological explanation of the reflex, we can afford to prescind from the electrical changes which the somatic disturbances we speak of, work in the body. In this connection see the reference to the work of Thouless, p. 29.

largely determines what he finds on introspection. Hence our Subject's failure to report conscious emotional processes in those reactions where conative activity was especially prominent, is no conclusive argument for the actual absence of somatic disturbances. In fact, at least in many cases, the physiological changes may have been so strong that the Subject would have been acutely conscious of emotion, if his mind had not been so engrossed in the performance of his task against the force of the obstacles which tended to impede its fulfillment. We might infer as much, by analogy, from a case of frequent occurrence. A man may be conscious of no strain at all while his attention is given to the execution of a delicate, exacting piece of work. It is only after he finishes it that he realizes that he is tired, and that his nerves are on edge. But we do not rely on inference to establish our claim that sometimes strong physiological changes of the kind which produce the reflex, had their parallel in experience, though the Subject did not observe them. We often have them reported *negatively*. Very frequently, after a reaction in which the conative activity was prominent, the Subjected reported:

"strong feelings of relief,"
"marked relaxation," etc.

In doing so, he reported the previous presence of a tension, masked and submerged during the actual reaction, but none the less experienced, though not consciously. While it was present it was not formally in awareness, but it becomes cognized by its absence. In other words, when the strain was removed the Subject's experiential state is changed; he knows he felt the strain when he begins to feel it no longer. When the last carriage of a "slip train" [6] is detached and the brakes applied in order to allow the rest of the train to run away from it, a man who is not attending to objects outside the carriage or to the

[6] The term may be unfamiliar to American readers. A "slip train" is a non-stop train from which the last car is detached while the train is going at full speed. After being detached the breaks are applied on this car until the train has run a safe distance away. Then the breaks are released and the detached car comes into the station by its own momentum.

grating of the brakes, does not notice that the speed is decreasing. When the brakes are quickly loosened and he has the impression that the carriage takes an unexpected leap forward, he realizes that he had experienced the gradually slowing motion. The carriage does not suddenly pick up speed; it only ceases from decreasing it. And so the feeling of relief and relaxation which comes into consciousness after the mind has ceased to be fully occupied with its own conative activity, is not something added to the previous bodily state; it is simply the removal of an organic tension which was in experience before, but not in awareness. So we conclude that in many of those reactions in which the Subject reported no emotion, there were physiological disturbances objectively strong enough to betray themselves as emotions, had these been attended to.

It may be objected, that such deflections should be included among those whose accompanying introspections report conscious emotion. Physiologically they belong there, but psychologically they do not; for, as we have said, it is not the organic disturbance, but the consciousness connected with it, which is an essential element of emotion. Hence, as psychologists, we are not justified in referring the reflexes to emotion (as is done by Radecki, Sidis and Kalmus, Binswanger, and others. Cf. p. 31), when there is nothing but conation in consciousness. But we are justified in referring them to the physiological disturbances, which are the partial cause of the emotion.

But how can conation cause a deflection? Indirectly: through the somatic changes it excites. When a Subject accepts a task and resolves to do some definite act according to instructions, and to do it as quickly as possible, he arouses a mental "set" in himself. As a result, he is alert to perceive the stimulus, understand what he is to do with it, proceed to do it, and lose no time in the process.[7] His alertness antecedes the appearance of the

[7] The same phenomenon is observed in the "breathless" attention a man brings to the execution of a critical action in which he is particularly desirous to succeed. The attention is "breathless" because strong, conative resolve had acted reflexly on his respiratory and circulatory systems.

stimulus and is sustained until the reaction is completed. "Pulses" of it are not infrequently reported. Now this is a mental alertness; but it has physical accompaniments, as is obvious from introspections in the earlier experiments, in which are reported physical tensions of which the Subject is vividly and sometimes painfully conscious. This is especially true during the fore period, when the heightened (expectant) attention has no other mental content to engage it. The conscious, conative resolve to carry out the instructions is observed to diminish rapidly as the experiments proceed; and simultaneously the physiological accompaniments become less apparent. When, however, some unusual difficulty impedes the fulfillment of the task, stronger conative tendencies are aroused. They are accompanied by greater physiological tensions; a greater reflex is registered by the instrument, and the experience may be cognized as strongly emotional.

Experimental investigations are unanimous in showing that the resolve to carry out the instructions becomes weaker and weaker in consciousness with the progress of experimentation, and eventually becomes so faint that it is unamenable to introspection. But it is not dead; as is shown by the fact that it influences the reaction and guides it to a correct and rapid completion. Since that conative resolve is present and operative, its accompanying organic tensions may be fairly supposed to be present also. They, too, may be too faint to colour consciousness; but they cause a fall of resistance great enough to be detected by the galvanometer. Conation is an inclination towards, or away from, some object apprehended as good or bad. Such an inclination may be instinctive or unconscious; as may happen when the Subject's instinctive desire to assert himself favourably urges him, unconsciously, to exert himself to put forth that conative activity which will insure the right reaction. Thus we can explain those "automatic" and "mechanical" and "habitual" reactions, of which we have so many, and for which there are

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When he has grown accustomed to the task he is no longer conscious of such tensions, though suitable experiments prove them to be present.

measurable deflections. In such reactions the unconscious "determining tendency" is operating; as is proved by the fact that the Subject responds in strict accordance with the instructions. Therefore conation is involved, and this arouses a physiological tension so weak indeed that its mental counterpart is below the threshold of consciousness, but still strong enough to cause a deflection of the galvanometer.[8]

Summing up what we have said: We think that the psychogalvanic reflex is obtained, not only when the Subject consciously experiences an emotional state, but also when he is conscious of nothing but pure conation, unaccompanied by surprise or other emotion.[9]

The psychogalvanometer does not measure mental conative activities as such, but is an indicator of the organic changes aroused by those activities. We think these changes have a relation to the sympathetic nervous system and are physiologically the same in all cases. An emotional stimulus provokes a strong conation, and this in turn excites organic changes so strongly that they flood consciousness. When an unusually strong conative effort is required to fulfil a task, when, for instance, inhibitions and hindrances militate against the Subject's desire to react

[8] Starch seems to agree with our conclusion that conation operates to produce a fall in resistance. He states that automatic mental activity produces less change than voluntary mental activity, and it seems, he says, that voluntary muscular activity produces greater deflections than involuntary. Cf. Starch, D., "Mental Processes and Concomitant Galvanometric Changes." *Psy. Rev.*, Vol. XVII, 1910. Some maintain, against the more common opinion, that the deflections are due to the REPRESSION of emotion rather than to its expression. In our view, the repression of emotion *would* cause a reflex. It would involve strong conative activity. Moreover, another factor might enter in to increase the Subject's organic tension, namely, his desire to suppress one emotion might give rise to another—of anxiety.

[9] As was noted before, the greatest deflections we obtained were those for reactions when the Subject was conscious both of emotional tone and conative activity. Undoubtedly in those reactions, the organic disturbances were unusually strong since they forced themselves into the field of awareness despite the fact that the Subject's conative strivings were strong in consciousness. The deflections when both conation and emotion are reported, are 13 per cent greater than those for reactions where there is only conscious emotion.

as quickly as possible, the conflict may result in conscious emotional states because of the pronounced physiological tension; the consequence, on the physical side, is that there are large deflections. By analogy we argue that when conation is present but no conscious emotion (as happened very frequently in our experiments), there is none the less considerable physiological disturbance. The Subjects were always desirous of reacting as quickly as possible, in pursuance of the instructions. There was always some hindrance in the way, if it was only the finding of the appropriate response; and the conflict resulted in a bodily tension. This was not strong enough to manifest itself to consciousness; but it was neither so fleeting nor so faint as to elude the sensitiveness of the galvanometer. Considering the delicacy of the reflex, this is not to be wondered at, since Shephard found that such gross phenomena as the vasomotor and respiratory changes which are prominent in emotional excitement, are present, to some extent, in all forms of conscious activity.[1]

We think the physiological causes of the reflex are always specifically organic changes, which, when they are violent enough, come to cognition as emotions; when they are perceptible, but not inordinate, are designated "feelings"; and which sometimes are so feeble as to escape introspection altogether.[2]

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[1] "Organic' Changes and Feeling," by Shepard, J. F., *Amer. Jour. of Psych.*, Vol. XVII, 1906, p. 559.

[2] Under the direction of Professor McDowall and Doctor Aveling, we have lately carried out a series of experiments with the psychogalvanic reflex in the physiology department of King's College.

Reactions were obtained from cats which were anaesthetized by ether and intravenous injections of chlorolose. One cat was decerebrated, two others had both carotids tied off and were, therefore, equivalently decerebrated. In such animals there can be no question of emotion, if the theory that localizes emotion in the higher levels of the brain is correct. Yet nocive stimuli, of the kind which produced deflections in the conscious Subject, caused essentially the same reflexes in the cats, i. e., they produced a fall in resistance. Drugs which caused a constriction of the blood vessels, produced a fall in resistance, those which caused a dilatation, produced a rise. This is an instance of the "unconscious conation" of which we spoke above. It is a conative response of the involuntary musculature as it reacts to the influence of drugs, or as a protective mechanism against injurious stimuli. The conscious element is excluded by the fact that the cats were anaesthetized, and in some cases decere-

brated. In fact such vascular changes as were produced in the animals through the action of drugs, would, usually, be unconscious even in the conscious Subject. In him they could be reflexly effected by the perception of a stimulus which was of a nature to arouse conative strivings towards, or away from it. Such circulatory changes are common and patent in the pallor of fear and the blush of shame. But in a conscious man, nocive stimuli and others of an exciting, startling, or fearsome kind, would cause changes in other parts of the smooth muscles, besides those in the walls of the blood vessels. That is why we refrained above from attempting to specify with anything like exactness, the precise nature of the organic changes and tensions which we claim are the immediate causes of the reflex. We were satisfied to refer such changes to the involuntary musculature in general, under the influence of the autonomic nervous system. The interdependence of one part of the living organism on others is so intimate, that it will require a vast amount of physiological experimentation to justify us in venturing even a rough estimate of the relative effect a change in any one part may have on the psychogalvanic reflex. This is true in the case of an anaesthetized animal. It obtains, *a fortiori,* in the conscious, human Subject. For in him a multitude of other factors interfere to complicate the reaction.

The results of the experiments referred to above are set forth on their physiological and psychological sides, respectively, in the two following papers:

"A Note on the Psychological Significance of the Psychogalvanic Reflex in Anaesthetized Cats." *Brit. Jour. of Psych.*

"A Skin Constrictor Reflex." *Proc. of the Roy. Soc.*

Both these papers are by Professor R. J. S. McDowall and Doctor F. A. Aveling, and are still in the press. (April, 1925.)

MISTAKES IN REACTION

THE mistakes of his Subjects furnished Ach with much of the data from which he drew his conclusions about the Will-act. The false reactions given by his Subjects were of two kinds: either they gave an entirely irrelevant word as their response, or they reacted with the companion syllable (associate) of the stimulus. Ach emphasizes this latter kind of false reaction, which he calls "Intendiert Fehlreaction," because, he says, it manifests the strength of the associative tendency. In our experiments this kind of false reaction is the rarest exception. Only once in the first group was the associate syllable given as the response to the stimulus.

One of the original nonsense words learned was LUP-AC. On the tenth day of experimentation, A was shown the initial syllable LUP in red—which instructed him to rhyme it. He had reacted to this syllable in different ways six times previously, and always correctly; but on the day in question he responded with the associate, pronouncing it PAC. The time for this particular reaction was exceptionally long for this Subject (4279 sigma). The introspection for the reaction is the following:

> "I saw LUP, red, but the colour carried no meaning." (i. e., it did not convey to the Subject the nature of the task.) "AC developed with auditory-kinaesthetic imagery. Then there were several strong pulses of conscious activity to get the meaning of the Colour. It seemed to be taking a long time. Then the meaning "rhyme" developed, and with kinaesthetic imagery from the tongue, after some difficulty PAC came as the reaction." (A—90th reaction.)

At this stage of A's experiments learned and unlearned syllables were being exposed to him indiscriminately; and he differentiated them by his recognition of the fact as to whether they had associates or not. The appearance of the associate to the stimulus does not, therefore, necessarily argue any great strength

of association—no indication of it is reported in the introspection. The Subject felt no inclination to respond with the associate syllable; on the contrary, he immediately turned his attention to the colour, which was to acquaint him with the nature of his response. It was *then* that the difficulty began. He could not remember the significance of the red colour, and when, after

"several strong pulses of conscious activity,"

he succeeded in recalling that the red meant to rhyme, he was aware that the reaction was taking

"a very long time."

Still no rhyme came and he reacted PAC, probably because that was the last word which he had definitely in consciousness. This isolated case affords us no basis of argument.

C had two false reactions, in which the response was a mixture of the associate and the word called for by the instructions. In both cases the stimulus, task, and response were the same. NYG-OC was one of the original ten words learned. On the seventh day C was shown the syllable NYG in black, the colour telling him to change the Y into some other vowel. On the second day he had carried out this reaction correctly with the same stimulus. On the fourth day, when shown NYG in blue—which left him at liberty to rhyme it, or reverse as he chose—he had reacted correctly, and transposed the consonants. When he was shown NYG the third time—on the seventh day—with instructions (by the colour) to change its vowel, his reaction was NOC. On the twelfth day he gave this same response to the same stimulus. His reaction times for the two cases were 2145 sigma and 2323 sigma, respectively,—rather long for this Subject, whose reaction times for the task of changing the vowel average 1536 sigma, with a m. v. of 222. The introspection for the reaction of the seventh day follows:

> "I recognized the word as familiar and the colour carried its meaning. OC (the associate), came auditorily but not strongly. With a mental 'rush' I started to change the vowel but I rhymed the final syllable instead. There had been a

> swing of attention from OC to NYG. I knew what I had to do, but something seemed to force me to rhyme the last syllable, though originally the OC did not seem strong at all." (C—49th reaction.)

The introspection for the reaction on the twelfth day is interesting:

> "NYG appeared somewhat hazily; there was a flash of attention to the right of the stimulus and OC came up. Then there was an intentional direction of attention back to the stimulus word, but it lacked the sureness I usually feel in that backward swing. All the time I was struggling to know what to do with the black NYG. OC was still reverberating in consciousness, and after trying in vain to realize what to do with NYG, the O of OC seemed to slip into the place of the Y, I think auditorily, and I responded NOC." [1] (C—95th reaction.)

It may be that the mistake in this second case is due to Perseveration from the first. In both the reactions, the response may have been influenced by the associate, though there is another possible explanation. It lies in C's general attitude towards the task of changing the vowel. He regarded this as the easiest of all the reactions, and eight of his eleven mistakes in the course of a hundred and eighty-four experiments, were made when he was called upon to change the vowel. This argues a lack of attention for this task. Moreover, he had fallen into the "set" of substituting an *O* for the vowel of every black stimulus shown him, twenty-eight of his thirty-one correct reactions having been formed in this way. In the first case above, when the black NYG was exposed, he recognised it as learned, by recalling its associate OC. He was conscious of the meaning of the black as "change of vowel," and began to carry out his usual method of changing the vowel of the stimulus into *O*. This blended with the OC which

[1] It will be observed that the response NOC is a partial fulfillment of the instructions, the vowel is changed. But the correct response should have been NOG, and the associate is not NOC, but only OC. The response, therefore, is a mixture of associate and the reaction called for by the instructions.

"was still reverberating in consciousness";

and his unfocussed attention allowed this to be given as a response. This explanation appears likely, and if it is the true one, the emergence of the associate in these two reactions of C, does not point to any more pronounced influence of the Associative Tendency than was observable in A's response referred to above. Since these are the only three cases we have, in which the syllable associated with the stimulus appeared in the reaction, we are justified in assuming that the Associative Tendency did not influence the *verbal* response.

Counting omissions, when no response at all was given, as mistakes, we have forty false reactions in a total, for five Subjects, of 909 experiments.[2] This makes the percentage of error for all reactions 4.4 per cent. The different Subjects show individual differences in the frequencies of their mistakes.

TABLE VII

(False Reactions)

Subject	*Number of Reactions*	*Average Reaction Times in σ*	*Number of Errors*	*Percentage of Error*
A	190	2209	17	8.8
B	192	3064	1	0.5
C	184	1688	11	6.0
D	191	3330	2	1.0
E	152	1347	9	5.9

There is rough inverse correlation between length of reaction time and frequency of error. B and D, with the longest Reaction Times, made the fewest mistakes. E has a shorter Reaction Time and fewer mistakes than either A or C; but their longer times are largely due to the fact that in mixed sets, they delayed to identify the stimulus as old or new, which E did not linger to do. This process of identification, besides lengthening the time, seems also to have interfered with the correctness of the response. The mental operations became more involved, and the

[2] There were seven omissions and thirty-three incorrect verbal responses.

amount of mental energy the Subject brought to the task was scattered over a wider field, the attention being thereby less concentrated on the particular reaction required. We base this conclusion on the discrepancies shown between the number of errors made by E, and those made by A and C, when the mixed stimuli tempted the two latter to identify the different syllables.

TABLE VIII

	Mixed Stimuli (both old and new)		*Only old or only new Stimuli*	
Subject.	*Number of Errors*	*Per Cent of Total Errors*	*Number of Errors*	*Per Cent of Total Errors*
A	11	58.8	6	41.2
C	10	90.9	1	9.1
E	2	22.2	7	77.8

A and C have a relatively higher percentage of error in the mixed sets, when they were occupied with the process of identification, than E has, who did not bother about such identification.

Table IX shows the mistakes for all Subjects made in the fulfillment of the different operations:

TABLE IX

	Rhyme	*Transposition*	*Change of Vowel*	*Choice*
Number of Reactions	228	221	232	228
Number of Errors	9	6	22	3
Percentage of Error	3.9	2.7	9.4	1.3

The task showing the highest percentage of error, that of changing the vowel, was declared by all the Subjects to be the easiest; while that involving a choice was reported the hardest, though it shows the fewest mistakes. We think both facts have the same essential explanation, which is to be sought for in the amount of attention given the two operations. The "choice" reaction was recognized as a critical one; and the Subjects carried it through with a concentration of attention sufficient, in the vast majority of cases, for successfully coping with the

difficulties and securing a correct response. With the task of changing the vowel, however, the Subjects' mental attitude was different. They felt that the operation did not call for much effort, and therefore they did not sharply focus their attention on it. Often our Subjects did not realize that they had made a mistake when reacting to the black syllables until long after the reaction. The Subjects' state of mind towards the task symbolized by the black, was not due to a perfunctory attitude nor to a conscious lack of seriousness. The writer knows this from personal experience; and he infers it from the protocols of the other Subjects. On the exposure of the syllable the Subject was keyed up to recognize his task, and react to the stimulus as quickly as possible. It was only when he became fully conscious that he had to change the vowel, that there was

> "relief when I saw it was black";
> "a feeling of pleasure when I realized that all I had to do was change the vowel";
> "the thought—oh, this is the easy one";
> "a feeling of friendliness towards the black"; etc.

This sense of "relief" is often accentuated in the "mixed sets," i. e., those in which the stimuli were made up of both learned and unlearned syllables. In such sets the Subject first gave his attention to the word and then to the colour. Therefore, at the beginning of the reaction, his conscious attitude was not influenced by the nature of the task: he did not yet know what the task was. The following introspection illustrates the processes involved in such a reaction besides bringing out the point we wish to make, namely, that the lack of attention in the operation of changing the vowel was not a conscious one.

(The stimulus exposed to the Subject in the case of this reaction was a black PYF. It closely resembles the first syllable of one of the learned words, viz., PEFIM.)

> "PYF seemed familiar; there was a swing of attention to the right of the word, then I recognized that it was like PEF, and that I had had the same difficulty before. Then PYF was cognized as one of the new words. I lost interest

> in it then, and gave my attention to the colour, and was much relieved to find it was black, and I had to change the vowel." (C's 30th reaction.)

We have many reports similar to this, though not all are quite so clear.

We argue, that when the stimulus appears, the Subject is on the *qui vive* to react quickly and correctly. When the task is recognized as difficult, his mental effort and concentration of attention are usually sustained to the very end of the reaction. When, however, the task is recognized as "easy," there is a relaxation of tension, an unconscious feeling that the reaction will take care of itself, a consequent shading off of attention and resulting errors.[3]

Therefore, the task must present a certain amount of relative difficulty to the Subject in order to ensure its most efficient execution. It must engage his serious attention, if it is to call forth the energetic effort productive of good results. And it must do this of *itself*; for otherwise the Subject must *force* his attention, and thus expend mental energy which he might be utilizing in the prosecution of his task; or else his attention will attach to something extraneous to the particular operation he is here and now engaged in. In either case he is hampered, and the perfection of his reaction will normally suffer.

The fact that the too great ease of accomplishment is a source of mistaken reactions, has already been noted by investigators in the field of Will-activity.[4] It has pedagogical implications. The boy who is in a class where the studies are graded for others less gifted than he, not only has time for mischief, but his work is desultory, slip-shod, and generally imperfect. He finds the

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[3] The relative preponderance of error in this task of changing the vowel is much more apparent in the cases of the individual Subjects, than it is in Table IX, where the average percentage of error is lowered by B, who performed this task fifty-one times without a mistake. Forty-four per cent of all mistakes of E were made in this task of changing the vowel, while 47 per cent of all A's mistakes, 73 per cent of C's, and 100 per cent of D's, are with this reaction.

[4] A. A. Roback, "The Interference of Will Impulses," *Psych. Monogr.*, Vol. XXV, 1918, pp. 43 et seq.

matter too easy. He does not give it his voluntary attention, and it does not extort his involuntary interest; with the consequence, that, though he may be the brightest boy in the class, his marks are far from being the best. It would be his salvation to be put in a higher form. There the successes of his fellows would spur him on to a greater output of energy; and the increased difficulties of the studies, if they did not succeed in eliciting his spontaneous attention, would force him to better application. Of course it is this last which is desirable.

THE NATURE OF THE RESPONSE

When Ach introduced the expression, "determining tendency," into psychology, he attached a very definite meaning to it. He understood it to be a tendency which proceeded from the idea of the end to be attained and which unconsciously operated to the attainment of that end. It was set up by the acceptance of the instructions; in other words, the Subject's serious and conscious resolve to carry out the conditions of the experiment, aroused a tendency which determined him to employ the necessary means to bring about a correct reaction. When this determining tendency operates to produce the response, it operates unconsciously, so that during the actual performance of the task, the Subject is not explicitly aware why he reacts with a specific response to a certain definite stimulus.[5] Having accepted the task and resolved to carry it out, the actual steps in the execution of the process are directed by the unconscious determining tendency. It is in this technical sense that the term has come to be used in Will-psychology.[6]

[5] "Diese im Unbewussten wirkenden, von der Bedeutung der Zielvorstellung ausgehenden, auf die kommende Bezugsvorstellung gerichteten Einstellungen, welche ein spontanes Auftreten der determinierten Vorstellung, nach sich ziehen, bezeichen wir als determinierende Tendenzen." Ach, N., "Ueber die Willenstätigkeit und das Denken." p. 228. Cf. also p. 196, ibid.

[6] In other fields of psychology, whole hosts of determining tendencies have been introduced and sponsored by various authors. There are determining tendencies of the mind, just as there are of perseveration and association. Investigations into abnormal states have brought to light a great deal of information concerning the different kinds of tendencies, of the long spaces of time during which they are often active, and of the accuracy with which they determine an intended end. Study of post-hypnotic phenomena has been especially fruitful in this line. As a result of a suggestion given under hypnosis, a person feels an impelling inclination to perform a certain action at a certain time, without understanding any reason for this tendency. While his consciousness is fully occupied with other matters, some kind of unconscious conation is attend-

In this technical sense the determining tendency depends upon the conditions of the experiments, and is modified by the nature of the instructions. If the Subject is told to *rhyme* every stimulus he sees, the acceptance of the instructions sets up a definite determining tendency to rhyme. Less specific instructions would set up a less specific tendency. For instance, when we told our Subjects to "respond according to the colour of the stimulus"—in other words, to respond with the particular reaction which a given colour symbolized—we did not arouse a determining tendency to any one definite task. Since any one of four colours might appear, the only determining tendency our Subjects could have in the foreperiod, was one which prompted them to react correctly, and as quickly as possible, to *whatever* task might be called for. Other instructions would set up other determining tendencies, which, though they differed in respect to the end they unconsciously strove to reach, would all come under Ach's definition. But none of them would be primary or fundamental. Underlying all those specific determining tendencies and modifying them all, there are more deep-rooted, instinctive tendencies, which, though they may not influence the Subject to accept the task, do influence his execution of it, once he has voluntarily assumed it.

Many investigators believe that the most fundamental of all innate tendencies, is that towards the line of least resistance. Roback, for example, puts the course of least exertion as the primary, or dominant determining tendency, of which all others are manifestations, and by which all others are modified.[7]

Bauch found that the most frequent movements are the most rapid, and the most convenient, the most frequent.[8]

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ing to the fulfillment of a suggestion which involves an elaborate calculation. This looks like evidence for the simultaneous existence of two independent kinds of activity. Cf. e. g., T. W. Mitchell, "Medical Psychology and Psychical Research," London, 1922; also Dr. Milne Bromwell, "Hypnotism," London, 1903.

[7] Roback, A. A., "The Interference of Will Impulses," *Psych. Monog.*, Vol. XXV, 1918.

[8] Bauch, M. "Zur Gleichförmigkeit der Willenshandlung," *Fortschr. der Psychol.*, 2, 1914, pp. 340-569.

Bauch allowed his Subjects a choice of several arm movements, with

Certainly the tendency to lessen effort is strong in man, and of far reaching biological importance.[9] Its effects are more marked, perhaps, when the response to a stimulus is a series of voluntary movements than they are in experiments like ours, where the processes involved were almost entirely mental. Still this tendency did appear in our results and was manifested by the form of the verbal response. It is noticeable, that, whenever the nature of the task permits of it, the constant tendency of all our Subjects is to fall into a stereotyped form of response—a device which tends to lessen the amount of mental energy required for carrying out the instructions. This tendency is displayed conspicuously in the task of rhyming. The response in this case could be any rhyming word, nonsense or meaningful, and the simplest method of reacting was by merely changing the initial letter of the stimulus. All the Subjects show a marked predilection for some few particular consonants upon which they call, in making this substitution. Of C's forty correct responses with the rhyming reaction, thirty-eight begin with *S*. In D's fifty reactions of this kind, are found thirty-one responses beginning with *T*, and fourteen with *M*.

B rhymed the stimulus fifty times, seventeen responses begin with *N*, sixteen with *P*, eleven with *T*.

A distributed his responses more impartially. In his reactions, the rhyme begins with *H*, fourteen times; with *P*, twelve times; with *B*, nine. The other nine of his forty-four responses with this task, begin with different letters.

E noticed during his reactions that there was a tendency always to start his rhyme with one of two consonants, and he frequently

---

instructions to react as quickly as possible. On a hexagon, the sides of which were 160 mm. long, he placed six small circles, one on each angle of the figure. Another circle was placed at the centre of the hexagon. The Subject placed his finger on some point and moved it to any other, at a given signal. The Reaction Times and the length of the movement were taken. The shorter movement was preferred to the longer; that towards the body to that away from it; flexor to extensor; the quickest and easiest movement was most frequently selected.

[9] Still it is unwarrantable to generalize to the conclusion, that *all* of man's activities are shaped by a tendency towards the least resistance.

held up the reaction until he had found a different initial letter for his response. Yet of this thirty-five rhyming responses, sixteen begin with *G*, and ten with *K*.

On the task of changing the middle vowel of the stimulus, all the Subjects show a decided preference for *O* as a substitute for the vowel of the stimulus.

This phenomenon appears in 88 per cent of A's reactions with this task; 71 per cent of B's; 90 per cent of C's; 50 per cent of D's; and 44 per cent of E's. Forty-seven per cent of E's responses were made by changing the vowel of the stimulus into *E*, which is also an indication of a tendency to economize on the amount of mental energy expended on the operation.

When the Subjects were free to choose between rhyming the stimulus syllable or transposing its consonants, a tendency to prefer the latter reaction, is manifest in practically all the responses.

TABLE X

(Responses when the task was either to rhyme or reverse.)

Subject	*Per Cent Rhyme*	*Per Cent Transposition of Consonants*
A	22	78
B	67	33
C	47	53
D	36	64
E	46	54

Obviously the operation of transposing the consonants is preferred. This task was reported the easier of the two by all the Subjects, though its Reaction Times are about the same as those for rhyming. (Cf. p. 19.) B is the only Subject who favoured the rhyme as a response in the "choice" reactions. Her introspections frequently report that she did so intentionally,

"because it was more difficult to react with a rhyme."

E had a strong conscious tendency to react by transposing the consonants. He deliberately struggled against this inclination, with the result that his responses are almost equally divided.

C's responses show a similar distribution. The "set" which he manifested when the task was to rhyme, namely, to change the initial letter of the stimulus syllable into *S*, displayed itself in the "choice" reactions also; 73 per cent of his rhymes, when he was at liberty to rhyme or transpose, begin with this letter. With such a "set" it was as easy for him to rhyme as to transpose.

It is evident from the above figures that there is a pronounced tendency to economize on effort and to favour the easier reaction. This tendency shapes the character of the verbal response when it is allowed to operate unconsciously and is not deliberately checked by the Subject. This phenomenon is analogous to what has been reported by those who have investigated volitional activity by a study of voluntary movement. In such researches, the unconscious tendency to favour the most convenient and expeditious movement has been repeatedly observed. In the particular conditions of our experiments, this tendency manifested itself as an inclination to react with the easiest verbal response.

Study of Will-activity has brought to light another unconscious tendency, that of eliminating unnecessary movements. This, too, appears in our results, modified, of course, by the specific conditions of our research.[1] The process of "short-cutting" was displayed by our Subjects in the elimination of unnecessary cognitive and conative processes, and in the symbolization of many of the necessary ones. The conditions of the experiments afforded ample opportunity for such a method of procedure. The Subjects had first to perceive the colour of the stimulus, and then to recognize what definite operation it stood for. Besides they had to cognize the stimulus as a syllable in order that they might build a proper rhyme to it, or transpose its consonants correctly, etc. Then, when both the task and the syllable with which it was concerned were known, they had to search for the

[1] The only motor-activity involved in the reactions of our research, was releasing the pressure of the teeth and lips on the bulb which acted as a lip key. This action was performed automatically when the Subject began to pronounce his verbal response. It became unconscious after a remarkably small number of reactions.

appropriate response and pronounce it verbally as their reaction. In this complicated process a gradual economy of operation is observable, especially in respect to the recognition of the meaning of the colour.

In a preliminary series of reactions, extending over a period of four or five days, the Subjects had been practised in recognizing the tasks symbolized by the four different colours. When this recognition had become smooth and easy, and reaction times constant, the actual experiments began; but under the new conditions the Subjects had some difficulty in cognizing the meaning of the colour. This did not last long, it is true; but it is reported by all the Subjects in the early stages of the experiments. At first the Subjects had recourse to a mental recall of the instructions as a whole, in their effort to grasp the meaning of the colour; e. g., A reports in his introspection for the fourth reaction of the first day:

> "When I saw the black FIV, I reviewed all the colours imagelessly, then I thought 'black—change the vowel.'"

And E says, in his third reaction of the first day:

> "As soon as I saw the red PEF, there was a sort of mental list of the different colours."

B reports the same phenomenon in the third reaction of the first day:

> "When I saw the stimulus, it seemed utterly unfamiliar. I was baffled, confused, and worried. I could not get the meaning of the colour; and this did not come until I had consciously repeated the whole of the instructions."

C says in the fifth reaction of the first day:

> "When I saw the blue BAZ, there was some doubt as to the task. My mind seemed to wander around the instructions, though I was not explicitly aware of them; and I finally lighted on 'blue' in the list,' and then thought 'blue—rhyme or reverse.'"

Such introspections occur repeatedly in the early reactions, but they are seldom found after the first day of experimenting. A

recall of the complete instructions, i. e., a mental review of the meanings of all the colours, was a cumbersome and useless process, since the task never had to do with more than one of them. The first step towards simplification in the recognition of the colour, was observed in the fact that very soon only that part of the instructions which dealt with the particular colour exposed, was consciously recalled. It was usually brought back by means of an auditory image. For instance, D reports in the introspection of his ninth reaction:

> "I saw TOUG, green, and had to think for some time of the task to be done. Then I had the thought, with an auditory image, 'green—reverse.'"

After this the process of recognition became shortened to:

> "Saw DOM dominantly red. I knew what I had to do with it, though there was no explicit consciousness of rhyming." (A, 18th reaction.)

> "I saw LUP, blue, restful, pleasing. The blue colour carried a meaning, but not definitely. In fact I was never formally conscious of 'rhyme or reverse.' I simply felt that I knew what to do with the word and that I would react correctly." (C, 9th reaction.)

The above introspections show that the explicit knowledge of the task as such, grew faint as the experiments proceeded. The Subjects knew they would react correctly without being formally aware of the precise nature of the task. All the Subjects are definite and emphatic in declaring that they experienced this phenomenon. Blue—the colour for the "choice" reaction—came to mean:

"two alternatives,"
or
"do one of two things,"
or
"do either";

but there was no definite knowledge of what the alternatives were. (They were "rhyme" or "reverse.")

Then came a further step in shortening the process of recognizing the task the colour imposed. It became manifest after

unlearned syllables were used as stimuli in combination with the learned ones. A spatial element appeared. Red, instead of signifying "rhyme," came to have the meaning of an activity associated with the first letter of the stimulus; or the first letter of a red syllable would occupy the focus of attention, as did the last letter of a green syllable (which was to be transposed). Black ceased to have the meaning of "change the vowel," and the task was cognized by the fact that there was an intentional direction of attention towards the vowel of the stimulus. Sometimes the vowel was reported as "taking on a sort of luminosity in consciousness." A blue syllable, since it left the Subject free to choose one of two possible ways of reacting, ordinarily involved more complicated mental processes than did the other colours; and, when the task began to be recognized in spatial terms, there is a corresponding complexity in the case of the blue. We have such reports as:

> "There was an intentional direction to the end of the word and then to its beginning";
>
> "An oscillation of attention from one end of the word to the other";

until some factor or other determined a focussing on one end, thus eliciting the appropriate response. At times the Subject tried to report the activity provoked by a blue stimulus in terms of geometry. The uniqueness of the following introspection and its clear expression of such an attempt, justify its lengthy quotation:

> "NYG appeared blue, unfamiliar, meaningless.[2] OC came, and NYG was then recognized as familiar. Then there was a double directional knowledge. I can only describe it by saying it seemed to me as if two lines were going out from me, forming an angle. I was at the apex, NYG seemed to be at the base. This was in no sense sensorial. I seemed to intend the right hand letter of NYG. There was no

[2] The terms "meaningless" and "meaningful" came to be used by our Subjects in a quasi-technical sense. The former signified that the task symbolized by the colour was recognized; the latter, that it was not. The above introspection is from A's 188th reaction.

consciousness of the instructions, but an imageless content that NYG had an equal value of either right or left. I chose the right and responded GYN."

We describe in another part of this paper how we introduced unlearned nonsense syllables as stimuli, alternating them with the learned syllables. (Cf. RESULTS, p. 76.) We note in the same place that as a result of this change in method, the primary object of the Subjects' attention on the exposure of the stimulus was the syllable as a syllable, whereas before it had been the colour which engaged their attention. This change in the quality of attention favoured the emergence of the syllable associated with the stimulus syllable. The associate came to be intentionally localized to the right of the stimulus. This was undoubtedly due to the fact that in the list from which the Subjects had learned the original nonsense words, the associate *was* to the right of the syllable which later was exposed as a stimulus; for they both together formed a dissyllabic word. It would seem that the use of the unlearned syllables, by thus evoking the associate of the learned syllables, and localizing this associate in space, facilitated and hastened the translation of the instructions into spatial terms.[3] Our reasons for thinking so are these:

The Subjects' recognition of a syllable as new or old, was accompanied by a swing of attention to the right, and, therefore, away from the stimulus. When he had accomplished his task of identification, his attention had to revert to the intentional or sensorial image of the syllable in order to get the significance of the colour. The desire to save time and economize energy would prompt to a swing back to that precise part of the stimulus from which the required reaction was to start; viz., the beginning of the syllable in the case of a rhyming reaction, the middle when the vowel was to be changed, and so on. That swing back to

[3] It is very probable that the Subjects would have unconsciously come to interpret the instructions spatially, if unlearned material had not been introduced at all. Because, *de facto*, the specific operations involved in the experiments centered around some particular part of the stimulus, i. e., the rhyming reaction, for example, always began with the first part of the stimulus. We only maintain that such a spatial interpretation was *aided* by the introduction of the unlearned syllables.

the exact place came to be the ordinary phenomenon; and it is remarkable with what a feeling of assurance it is effected.

Now we can scarcely find an explanation for this fact in the conscious recognition of the task to be performed. In the first place while the attention was occupied with the word—as familiar or unfamiliar—the task imposed by the colour was not in consciousness at all. And secondly, when the prescribed task was recognized, it *was* precisely under the form of this accurate, speedy recall of attention to that particular part of the stimulus the reaction was to affect. There was no explicit consciousness of rhyming or reversing or changing vowels. In fact, in the later experiments, there was not even consciousness of the colour after the word had passed from the visual field. It would appear that the two tasks of recognition were being performed concurrently: while the mind was consciously occupied with identifying the syllable, it was subconsciously busy on the colour, and had its meaning ready when it was wanted. And the meaning took the form of guiding the conscious attention quickly and surely to the point of reaction.

All that we have enumerated in the foregoing pages seems to be good evidence that the unconscious tendency to economize on effort and to eliminate useless operations was manifested by our Subjects. The phenomena can be explained by the unconscious determining tendency towards the line of least resistance, as Roback, Bauch, Ferrero, Ribot, and many others maintain. It is at least probable, however, that other unconscious tendencies operate towards the same end. For instance, the unconscious conative tendency, which McDougall calls the "Self-Assertive Instinct," and which he claims to be one of the fundamental motives of activity, most likely influenced our Subjects in making their "short-cuts." Certainly this tendency influences a great number of the acts of a normal individual. There is no reason to doubt its operation in laboratory conditions. The acceptance of some particular kind of instruction sets up a specific determining tendency, in the technical sense of Ach. This serves as a channel to direct the flow of the pent-up force of the subconscious, conative instinct of self assertion. It is this latter

which prompts the Subject to react in a way which will make to his own satisfaction and win the good opinion of others. In laboratory experiments both these ends would be achieved by fulfilling the conditions laid down by the instructions. In our particular research, the instructions were to react according to the colour as quickly as possible. In such a case the self-assertive instinct operated to insure a correct response with the least possible delay.

We think it probable that both the tendencies—towards the line of least resistance and towards instinctive self-assertion—play their parts in the "short-cutting" observed so uniformly in voluntary reactions. Other unconscious factors may enter into the operation also; but the evidence of our experiments does not justify us in venturing an opinion on their nature.

SUBJECTIVE RESULTS

PHYSIOLOGICAL CHANGES

The physiological changes reported by our Subjects were, in general, those which are commonly observed when the conditions of experimentation involve alertness to perceive a stimulus, and concentration on a task to be performed. Since these changes have been frequently described and commented on, we may here enumerate them very briefly. They were most pronounced in the very early stages of the experiments; after which they gradually died down, until they were ordinarily below the threshold of consciousness. They reappeared when some unexpected situation arose, and often, too, as a result of a mistaken reaction.

Phenomenologically, the physiological changes took the form of a pronounced feeling of strain, which was wide-spread at first, sometimes involving the whole body. The location and spread of the tension varied somewhat with individuals, both in intensity and in duration; but all the Subjects concurred in reporting certain definite kinds of strain. Prominent among these were sensations of choking, feelings of tightening in the viscera, at the base of the throat, in the diaphragm and in the respiratory apparatus generally. The head was also involved. This was especially true of parts concerned with giving the verbal reaction; the teeth and lips strongly compressed the bulb, which served as a lip-key, and the muscles of the jaws and face were contracted. There were often sensations in the ear also, since that organ was affected by the warning signal. Tensions were reported from the eyes, forehead, and brows. These were various and difficult of description. In their efforts to characterize them the Subjects reported:

> "strain in the eyes,"
> "bulging,"
> "intraocular pressure," etc.,

but they were not satisfied that they gave exact expression to the phenomena they experienced. Of course we should expect some

ocular strain to manifest itself to consciousness, since the Subjects were alert to perceive the stimulus clearly and with the least possible delay. But the frequency and emphasis with which tensions in the eyes are reported, support the view that other factors, besides the mere strain of adaptation, were present.

McDowall has shown that a cat's pupils dilate widely with excitement when it is held at some distance from a dog.[1] When the dog is brought nearer, the cat's pupils constrict as it accomodates its vision to keep its enemy in clear focus. It has been repeatedly observed by physiologists that emotional states influence the balanced action between the sphincter and dilator muscles of the iris, thus affecting the size of the pupil and contributing to the facial expression characteristic of different emotions. Familiar phrases like "eyes dilating with terror," or "darkening with pleasure," are physiologically sound. Such pupillary reflexes may be brought about when the emotion is not one of immediate experience but only revived by memory.

It is probable that there were pupillary reactions in our experiments, though they were not directly or objectively observed. In the foreperiod, especially during the earlier stages of the experimentation, the Subjects were taut and strained in their anxiety to be set for the exposure of the stimulus. In this condition an added tension—which in other circumstances might not have come into the field of awareness—was strongly present to consciousness. Even so simple a stimulus as the warning tap of the electric hammer, had an emotional value which tended to arouse a reflex pupillary dilatation. Operating against this reflex, was the voluntary constriction of the pupil which the Subject maintained by keeping his eye accomodated to see the future stimulus which was soon to appear a very short distance away. If the reflex dilatation only had been present, the Subject would not have been conscious of it, and if the voluntary constriction had been unimpeded the muscular sensations might not have been observed. But when the two antagonistic forces operated against each other, and at a time when there was little or nothing else in

[1] Professor McDowall's paper is still in the press. It is to appear in an early issue of the *British Journal of Physiology*. (April, 1925.)

the Subject's awareness, he was vividly conscious of a strain. It was an unaccustomed strain, one, perhaps, which had rarely come into previous experience; hence the Subject's difficulty in describing it.

It may well be that a similar explanation accounts for another phenomenon which was noted by all the different Subjects. At times it is reported that the stimulus appeared:

"hazy and dim,"
"small and far away,"
"indistinct,"

that

"there was a tendency for the vision to fail";

and that

"the stimulus was perceived clearly, but then it became blurred," etc.[2]

All such conditions may be explained on the supposition that there is a reflex pupillary dilatation, either at the moment of exposure, when the Subject does not prevent it by accomodating for near vision, or after the stimulus has been clearly perceived, and there is no longer need for such accomodation. In this latter case the dilator reflex asserts itself either because the excitement persists in reality or in its physiological effect. The consequence of the dilatation is indistinctness in the vision of the stimulus.

As a usual thing the stimulus was perceived on exposure with remarkable clearness. This would be due not only to the fact that the eye had been already adapted to the distance at which the syllable appeared, but also to this further circumstance that the field of awareness shrunk so that other objective contents disappeared. The aluminum wheel of the tachistoscope was held by a magnet. When the current through this magnet was broken, the wheel was released with a twang and, after exposing the stimulus, was caught by a spring with a very audible click. Neither sound was heard by the Subjects except in the rare cases when no warning signal had been given, or when they had not

[2] Roback reports such a "blurring effect" in the case of his Subjects, and notes that the same phenomenon has been observed by other investigators. Roback, A. A., "The Interference of Will Impulses." *Psych. Monog.*, Vol. XXV, 1918.

noticed it, so that the first conscious intimation they had of the exposure, was when they were startled by the sound of the wheel's release. It is the same phenomenon that obtains in all intensive concentration, for instance, that of the man, engrossed in his own thoughts, who steps in front of an approaching lorry.

The feelings of strain we have described were not the effect of volitional activity as such. They were the result of novelty and excitement, and were essentially the same as the muscular, visceral, and glandular tensions which accompany the "emotional" situations of daily life. After the Subjects had become accustomed to the conditions of the experiments, the sensations of strain and tension shaded down, and appeared only when some unexpected situation arose.[3] They were the conscious organic effects of conative striving, but they were not essential constituents of the voluntary act, for they were not always observed in very energetic will-acts after the Subjects had become habituated to the conditions. In the later stages of the experiments there were undoubtedly physiological tensions; there were psychogalvanic deflections; but they were too weak to be introspected. They were not in consciousness as sensations and, therefore, they afford no psychological ground for arguing that the will-act is an aggregate or blending of sensations.

[3] The psychogalvanic deflections show an increase in size in the same conditions. When the organic tensions were strong enough to compel the conscious feeling of them, the reflex was larger than when they were so weak as to escape the Subjects' attention. The average deflections were largest in the early stages of the experiment, and later in unexpected or startling situations.

RESULTS

We began our experiments on the assumption that an exposed stimulus would recall its companion syllable so vividly, by association, that the Subject would be strongly inclined to react with it against the instructions. This had been the case in Ach's experiments, where very frequently the tendency to respond with the associate had been so imperative that it was yielded to, with resulting "Intendierte Fehlreaktionen." Other investigators have confirmed Ach's results, notably his pupil Rux, who showed that such false reactions occurred even when the subject had made in the foreperiod a strongly concentrated determination to react correctly.[1] We were surprised, therefore, to find, when we began experimenting, that with our Subjects the stimulus rarely evoked an associate; and in the few cases in which the latter was elicited, it came up weakly. In the beginning our Subjects performed the four tasks with the initial syllable of each of the ten original learned nonsense words. In all this series of forty reactions, the associate was never actually given as a verbal

[1] Rux, C. "Beitrag zur der Lehre von der Determination." Unters. II, 1913. Rux's Subjects set up strong associations between paired words by frequent repetitions. When the odd word of such a pair was exposed, the Subject was to react in a specific way. The words were of five letters and were selected with the greatest care, in order to preclude wrong reactions as effectively as possible. Only four pairs of words were used in a series and there were several different series:

A. A group in which the even word was formed by transposing the consonants of the odd, e. g., paget-tagep.

B. A group of pairs formed by transposing the vowels, e. g., paget-pegat.

C. A series in which the first word of a pair was a nonsense word and the second meaningful, e. g., ledon-loden.

D. A series of indifferent words. When a word of this series was exposed, the Subject could respond with any word he chose. This series was not to be learned by heart, but only read distinctly.

The number of repetitions varied with the different series (210, 60, 20). The Subjects were instructed to avoid false reactions.

response; and it came to consciousness comparatively seldom.[2] We then made a change in the method of procedure. With the learned syllables we mixed other unlearned nonsense syllables, and each day exposed four of the new, and four of the old, to which the Subject reacted as he had been doing before. Our idea was to investigate a possible latent inhibition, due to the associate when the stimulus had an associate. We thought we might find evidence of such an inhibition in the relative Reaction Times. The changes in the lengths of the reactions we have discussed in the chapter on Reaction Times; here we confine our attention to a phenomenon which was conspicuous when the conditions of the experiments were changed.

Immediately upon the introduction of the unlearned syllables, the associates to the learned ones regularly began to appear. With four of the Subjects they were almost invariable; though, as we have noted, they were the decided exception before. They came up, however, in a perfunctory sort of way and did not directly impede the reaction.[3]

The following Table shows the relative frequencies of the appearance of the associates under the different conditions we have just described. The figures tell the number of times the initial syllable of the learned word evoked the associate to consciousness; first, when only learned syllables were used as stimuli (column I); and secondly, when mixed learned and unlearned syllables were exposed (column II). There were forty reactions, for each Subject, in each of these two conditions.

[2] In our consideration of the Mistakes of Reaction, we discuss three cases in which the associate appeared, entirely or partially, in the response. These three false reactions were made comparatively late in the experiments. At present we are speaking of the failure of the associates to appear in the beginning of the experimentation—the time when they might most have been expected.

[3] See p. 23 (Reaction Times).

TABLE XI

(Frequencies of Appearance of the Associate.)

Subject	*Learned Syllables* *I*	*Mixed Syllables* *II*
A	0	39
B	4	29
C	0	36
D	18	36
E	0	1

These are significant changes and more than fortuitous. Our protocols seem to explain them.

It will be remembered that previous to the exposure of the stimulus, our Subjects did not know the nature of the specific task they would be called upon to do. They could have no determining tendency to rhyme, or transpose, or change the vowel; since they were ignorant of which of these particular operations they would be expected to perform. The only determining tendency they could have at this time was to react quickly and correctly. This made them alert to lose no time in becoming acquainted with their task; and, since their instructions were carried by the colour, it was on the colour that their attention was primarily centered. This statement is founded on the introspections of the various Subjects. The following few are taken at random, and are typical of the great majority of the reports when the stimuli of the reactions were the learned words only.

> (Stim. FIV (AG) in green): "Saw FIV green; knew greeness had a meaning; did not know what. Then some fragmentary auditory-kinaesthetic imagery, with knowledge that green meant *reverse*. Read word again; and reacted by reading the stimulus off backwards." (A, fourth day, second Reaction.)

> (Stim. DOM (IL) in blue): Perceived DOM blue; but the meaning was not clear until I had intentionally distinguished it from black. Then was conscious of the task;

and was a search for a rhyme." (A, fourth day, fourth Reaction.)

(Stim. TOUG (IR), black): "I perceived the stimulus first as black with the meaning of the process and then as a four-lettered word. Then I had to go back again, with eye movement, to read the word. There was a vague knowledge of the difficulty of responding with four letter words, etc." (B, third day, seventh Reaction.)

(Stim. PEF (IM), blue). "My perception of the stimulus was very smooth and untroubled. The dominant factor in consciousness, clearly occupying the center, was that I had to choose. (B, fourth day, first Reaction.)

(Stim. DEEZ (OL), red): "I perceived DEEZ, red. I became aware almost immediately that I had to rhyme and had no difficulty in finding a rhyme. While this was going on 'OL' seemed in the background of consciousness—the 'OL' did not come at once after I perceived DEEZ—my mind was occupied by the task but the 'OL' was vaguely present as something I could get when I wanted it." (D, second day, sixth Reaction.)

(Stim. LUP (AC), red): "I saw the red LUP, but I did not know what to do with it. I just waited for its meaning to grow—when nothing came I started to read the word L U P ; when I came to P there was a tendency to reverse —but I looked at the whole word again and then knew it meant I had to rhyme. Then I tried to recall the last syllable of the word and I could not. I gave response K U P." (E, third day, third Reaction.)

It is plain that the usual process was:

1. Reading of the syllable.
2. A recognition of its colour.
3. The realization of the meaning of that particular colour, i. e., a realization of the task.
4. A reversal of attention to the word about which the task was to centre.
5. This was followed by the actual execution of the task.

It is true that at the very beginning the Subject saw the syllable, but it was primarily as a *coloured* one. At the instant of exposure, the time best suited for the appearance of the com-

panion syllable because of Contiguous Association, the Subject focussed his attention formally on the colour. Now the mental associate of the colour was not a syllable but the task; and therefore, when the Subject fixated his attention on the colour, he facilitated his recognition of it and a realization of its meaning; while at the same time he minimized the chances of the emergence of the associate. When after recognizing the meaning of the colour, he gave his attention more closely to the syllable itself, the time was not propitious for the spontaneous appearance of the associate. Moreover, even while the Subject's attention was engaged with the stimulus as such, his mind was partially occupied with the task he was to perform with it, and with overcoming the difficulties in the way of the prosecution of that task. This state of mind was not conducive to a conscious recall of the associate. We establish our argument on the positive reports in our protocols; and it is confirmed negatively by the following fact also. In the few cases where the associate appeared in the reactions of B, the introspections show that at the beginning of the reaction, the Subject's attention was on the syllable rather than on the colour. With B the associate came to consciousness four times: viz., during the first and second experiments of the first day, and again twice rather late in the series. The introspections for these reactions are as follows:

> (Stim. NYG (OC) in black): "There was confusion and a blank on the appearance of the stimulus. I was groping to discover my task. There was a very strong tendency for the associate to come which I had to fight against; though there was no knowledge of why I was fighting or of what I was trying to do. There was visual reproduction of the stimulus and consciousness of the word "black" with fragmentary verbal and visual imagery. There was then a knowledge of the process" (i. e., task). (First day, first Reaction.)

> (Stim. LUP (AC) in blue): "When the stimulus appeared my perception of it was muddled up with my perception of it as crooked. With Consciousness of Action I pulled myself together to shut out that idea and recall what I had to

do. The associate came into consciousness clearly. I think it was only *then* that I saw with any meaning that the stimulus was blue." First day, second Reaction.)

(Stim. KAER (EL) in green): "I recognized the word KAER: EL was clearly in consciousness; *then* there was a knowledge of the meaning of the green. There was no struggle to give the associate. The green seemed undoubtedly the stronger." (Fourth day, first Reaction.)

(Stim. DOM (IL) in red): "Besides my ordinary perception of the stimulus, there seemed something startling about it; cannot analyze what this was. Repeated the word with inner speech twice—DOM, DOM. After that the associate came and I was conscious that all was not right . . . Then the word "red" was on the margin of consciousness, and I recalled that it meant to rhyme, etc." (Fifth day, sixth Reaction.)

It is noticeable that in the first of these introspections B reports:

"groping to discover the meaning of the task."

This condition of "groping" was favourable to a greater concentration on the syllable than would have obtained, had the meaning of the task been clear immediately, thus drawing the Subject's attention to itself. The attention, in its efforts to fix on something definite might well be attracted by the exposed syllable, thus favouring the appearance of the associate. In the second case, the fact that the stimulus was "crooked," attracted the attention to the syllable as such, and held up the recognition of the fact that it was *blue*. Something analogous seems to have occurred in the fourth reaction where the "red" was on the

"margin of consciousness."

a relatively long time only after the exposure of the stimulus. Though these introspections are not conclusive in themselves, they offer corroborative evidence of the positive proof we have in our protocols, that the emergence of the associate into consciousness depends on whether the attention is primarily given to the colour, or to the syllable itself.

On this point of the appearance of the associate, D's case is a conspicuous exception to that of the other Subjects. In eighteen

of D's forty reactions with only learned syllables as stimuli, he reports that the associate was present to consciousness; thought he usually adds that it was:

"weak," or "vague," or "very hazy,"

and that he felt no tendency to *respond* with it. A few of D's associates appeared in reactions where some accidental circumstance, such as those reported by B, intervened to focus his attention on the syllable; e. g.,

> (Stim. NAUR (EK) in green): "I had difficulty in seeing the last part of the stimulus word; I convinced myself it was NAUR and immediately there was a vague thought of EK." (First day, fourth Reaction.)

> (Stim. DOM (IL) in black): "Saw DO; was uncertain of the last letter; seemed to be H. Then there was a mental reference to my list of words, when DOMIL arose; and I decided that the stimulus must have been DOM. Then the fact that it was black, recurred to memory." (D, second day, third Reaction.)

D was more leisurely in his reactions than the other Subjects.[4] He was not on the *qui vive* to spring to a recognition of the colours as they were; but *invariably* the reactions in which no associate appeared to him were those in which the colour was vividly perceived on the exposure of the stimulus. D's usual mental process when the associate did appear, is described in the following introspection:

> (Stim. NYG (OC) in black): "I read NYG pronouncing it NIG; mind then a blank. Then 'OC' came into consciousness, followed by a coupling of the two syllables and inner pronunciation of NYGOC. I was aware before that NYG was black; but was unaware of the meaning of black until after the process I have described." (Third day, sixth Reaction.)

It is clear that D's attention was not primarily given to the colour; which is another argument for our contention that the

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[4] Cf. Reaction Times, p. 19.

kind of associate that appears, is conditioned by that objective feature of the stimulus which attracts attention.[5]

We have attributed the failure of the associates to emerge when only learned syllables were used as stimuli, to the direction of attention; we think the same cause accounts for their regular appearance when the learned syllables were alternated with unlearned ones. As has already been noticed, our purpose in introducing the new stimuli, was to get comparative data on the Reaction Times, respectively, of the learned and unlearned syllables. We had not anticipated the appearance of the associates; in fact we were greatly astonished when they came up as they did.

In the experiments with mixed stimuli the instructions were the same as before; i. e., the Subjects were simply to respond by performing a task indicated by the colour. In reality, however, most of the Subjects set themselves to perform a double task. They carried out the instructions of rhyming the stimulus word, transposing its consonants, or changing its vowel, as the case might be; but, before applying themselves to the specific operation required, they fulfilled another—unconsciously self-imposed task—of identifying the exposed syllable as new or old. We have argued that it was this new task of recognizing the stimulus as learned or unlearned, that caused the emergence of the associate, when there was one. In order to illustrate the processes involved in the changed conditions of experimentation, we quote a few typical introspections:

> (Stim. NYG (OC) in black): "I saw NYG emphatically black but without meaning. OC came, auditory-kinaesthetic, then NYG was recognized as familiar—not before. Then the meaning of the colour developed imagelessly." (A, seventh day, second Reaction.)

> (Stim. NAUR (EK) in red): "Perceived NAUR as a bad red and unfamiliar.[6] The red had no meaning. EK came auditorily—quite clear; and then NAUR became familiar, though it was not sensorially present. A cold sort

[5] As noted above there is a task associated with the colour, and another syllable associated with the exposed *word*.

of groping for the meaning of the colour followed." (A, ninth day, first Reaction.)

(Stim. PEF (IM) in red): "Had an auditory-kinaesthetic image of PEF at the exposure; then IM; then PEFIM; then a knowledge of the meaning; then the response REF." (A, twenty-first day, second Reaction.)

(Stim. TOUG (IR) in green): "Saw TOUG green,[6] smudgy. It seemed incomplete and I wondered why. Then IR came to consciousness and I felt satisfied. Then the meaning of green began to grow under the influence of a positive effort I was making." (C, third day, fourth Reaction.)

(Stim. BAZ (UL) in blue): "Saw BAZ, blue, restful, pleasing, familiar. UL came up with force, but immediately sank out of consciousness. Felt I had no more interest in it. Then there was a difficulty in getting the meaning of blue." (C, tenth day, fourth Reaction.)

(Stim. PEF (IM) in red): "I read PEF and it was followed by IM. Then pronounced PEFIM. Then there was a mental state equivalent to: "it is red and therefore I must rhyme." Immediately I had decided this, I gave the response." (D, seventh day, third Reaction.)

(Stim. FIV (AG) in red): "I perceived FIV, red. Then my state of mind seemed to be one of active waiting. Different stimuli passed through consciousness, and finally I recognized that FIV was one of the old syllables. Then the instructions gradually developed and I knew that red meant rhyme." (D, eighth day, second Reaction.)

(Stim. NYG (OC) in black): "I read NYG and before the meaning of black came, I repeated NYGOC several times with inner speech. I was held up by this and for a moment I seemed incapable of banishing the NYGOC or of getting any other meaning. There was a knowledge that everything was not right. Then I recognized the meaning of black and knew what I had to do." (B, seventh day, third Reaction.)

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[6] It is evident that the syllable was perceived as coloured on the instant of exposure, for the colour is described as a "bad red," "a smudgy green," etc. But the *meaning* of the colour is cognized only after the syllable is identified as familiar or unfamiliar.

These reports are representative of many. They make it plain that with mixed stimuli the process followed by most of the Subjects was as follows:

First, the identification of the stimulus as old or new; then a recognition of the colour; then a realization of its meaning; then the fulfillment of the task required. In other words, whereas before—with only learned syllables as stimuli—the attention was sharply focussed on the colour (which was not conducive to the appearance of the associate), now, with mixed syllables, the attention is fixed on the syllable.[7] This is done at the instant of exposure—the most favourable moment for the spontaneous appearance of the associate. Moreover, the Subjects generally discriminated the old syllables from the new by the fact that the latter were completed by an associate, which introduced a conscious element into the process of recall.

In Table XI above, it is seen that E had no associates in the first series of experiments, and only one in the second. He did not interest himself in the question as to whether the stimuli of the series of mixed syllables, were old or new. He simply reacted to the colour. It was on this that he centered his attention; and no syllable was associated with it. His general attitude is summed up in his introspection for the rhyming reaction with the stimulus LUP:

> "When I saw LUP, I was not very conscious whether it was old or new. I did not recognize it as old; but I did not think of it as new. The redness of the letters was very prominent."[8] (E, sixth day, eighth Reaction.)

The first reaction of the series with mixed stimuli is the single case in which E was conscious of an associate. The intro-

[7] As one Subject put it: "I think my mental 'set' before the exposures, is entirely concerned with the word that is to appear—whether it is new or old; until I have satisfied myself on that point, the colour is not in consciousness as 'meaningful' at all" (i. e., there was no conscious recognition of the task the colour symbolized).

[8] E's indifference to the quality of familiarity of the stimuli, had the further effect of making his reaction times with the mixed syllables much shorter than those of any other Subject. We comment on this fact in the chapter which deals with the Reaction Times.

spection for this reaction casts no light on the phenomenon. It is possible that E was influenced by the changed instructions, which made reference to the fact that both new and old syllables would be exposed.

In the mixed series the associate appeared to B in twenty-nine instances. It failed to do so eleven times. B was not forewarned that the mixed learned and unlearned syllables would be shown, but was allowed gradually to realize this fact for herself. A growth is observed in the process. At first the new stimuli were

"seen indistinctly";

but at the time there was no positive recognition of the fact that they were strange. Then the

"general appearance of the word"

carried the conscious knowledge that the syllable was old or new.[9] After that, the actual stimulus syllable was attended to; and it was then that the associate began to appear with regularity. Of the eleven cases in which B had no consciousness of the associate, six occurred during the first nine reactions in the mixed series. Two others, which were successive, occurred when the Subject was badly adapted for the experiment. The remaining three are scattered; and the accompanying introspections suggest no explanation of the absence of the associate.

It seems clear that the appearance or non-appearance of the associate is conditioned by the quality or direction of attention. When the Subject attends to the stimulus as a syllable, its companion syllable comes up; when he focusses on the colour, the associate fails to emerge into consciousness.

Ach, and Rux, and those who have experimented along the same lines, instructed their Subjects beforehand precisely how they were to react to the stimulus; so that, in consequence, the Subjects' attention was fixed on the syllable to which they were to respond in an already known way. The results were frequent

[9] The new syllables which were shown to B, were of a slightly different kind of print than that in which the old ones were presented. This was not so in the cases of the other Subjects.

false reactions, in which the response was the associate syllable to the stimulus.

There is a broad conclusion to be drawn from the phenomena which were prominent in our experiments. If our interpretation of these phenomena is right, then some of Ach's conclusions about the determining tendency and the Associative Equivalent are incorrect.

As is well known, Ach thought that he found the Strength of Will embodied in the determining tendency. Since this latter was proportional to the will-act which produced it, he measured the Strength of Will by measuring the force of the determining tendency; and he tested this force by finding its capacity for overcoming obstacles which hindered the execution of a decision. In order to guage the magnitude of such obstacles, he created them artificially by setting up associations between the members of paired syllables. These associations were quantitatively measurable by means of a variable number of repetitions. If, then, the Subject was given a task of rhyming, the assumption of the task set up a determining tendency to execute it. When he is shown the first of the paired syllables he has learned, the determining tendency incites him to rhyme it; but his artificially created Reproductive Tendency urges him to respond with the second syllable.[1] A battle of tendencies ensues. That strength of association which can just be overcome by the determining tendency, Ach calls the Associative Equivalent. This is capable of measurement in terms of the number of repetitions, and, therefore, gives a more or less definite value to the determining tendency and, through this, to the will-act.[2] Ach found that the Reproductive Tendency he had established by the repetitions, often pushed aside the determining tendency his Subjects formed

[1] The tasks of Ach's Subjects were varied; but, for the sake of simplicity and brevity, we shall speak only of that of rhyming.

[2] This is logical if the factors mentioned by Ach are the only ones involved in the will-act. I can measure the quantity of water in a vessel by finding how long it takes to flow through a tube of known cross-section. But if the water is being simultaneously drained off through some other channel, my mathematically correct calculations will give an incorrect value for the original amount of the fluid.

when they resolved to carry out the instructions; and the response was the associate syllable instead of the desired rhyme. After such an "Intendiert Fehlreaktion," however, the Subject made a more energetic determination, and reacted correctly to other stimuli, even when the Reproductive Tendency was stronger. Ach maintains that such a correct response against a stronger obstacle is due to a stronger determining tendency, and therefore to a stronger will-act.[3] Selz claims that it is owing to the Subjects' power for concentration of attention. Rux denies this assertion by an appeal to his own experiments, in which the Subjects were explicitly warned against making false reactions, and made them nevertheless. We think both Selz and Rux are right—from two different points of view. It is not merely a matter of concentration of attention, but—and we think this is more important,—of the stage in the process at which the attention is applied.

A strongly concentrated attention in the foreperiod is no great safeguard against mistakes in the later reactions. This is manifest from Rux's experiments. We may assume that the Subject who accepts the instructions to rhyme, sets up a strong determining tendency, and that this tendency depends on the strength of the will-act which establishes it. This determination may occupy the centre of the field of consciousness during the foreperiod; but the appearance of the stimulus causes such a conscious decision to become vague and indistinct, when it does not drop out of the field entirely. The reason is that the stimulus syllable has a special interest for the Subject, since it determines the channel into which he is to release his pent-up energy. It is the *specific* syllable which he must rhyme here and now. Consequently a concentrated and often absorbing attention is given to the syllable, which does not conduce to the successful operation of the determining tendency to rhyme. It is from this determining tendency that the energy of a successful reaction is

[3] Ach's Subject D made three "Intendierte Fehlreaktionen" on the second day, and never made another though the repetitions continued through the succeeding days, and the Reproductive Tendency thus became stronger.

to radiate. But the condition *is* conducive to calling up the associate precisely because the attention is so restricted to the first of the paired syllables. The Subject is "set" to react quickly; he has lost explicit consciousness of the "rhyme" as such; his attention is full on the stimulus syllable as a syllable; and a false response results. Thus Rux is correct in saying that concentration of attention does not forestall mistakes in reaction, provided he is speaking of attention in the *foreperiod*; which he seems to do.

On the other hand, when there is consciousness of the task during the actual time of reaction, the associate is not given as a response. We base this statement on our own experiments. In them the conditions were such as to focus the Subject's attention on the specific task to be performed *during the actual reaction,* and after the exposure of the stimulus. Unlike Ach's Subjects, ours did not know before the stimulus appeared, that they were to rhyme it; they had to wait to see the colour before they knew what they had to do. Before the exposure their determining tendency was only to react quickly and correctly to some future coloured syllable; which meant that they must recognize both the syllable and the colour.[13] Their particular decision to react faded out of consciousness on the appearance of the stimuli—as is ordinary in such circumstances—but it was pushed out of the way by a conscious content which did not tend to make our Subjects unmindful of their task as happened in the experiments of Ach and Rux. On the contrary, with our Subjects the new content of consciousness was of such a nature, that it focussed the attention on the task, because it specified this precisely. This obtained forcibly when the Subject concerned himself principally with the colour which symbolized the task. In those cases no associate ever came to consciousness at all. When the attention was first given to the syllable, in an effort to identify it, or for any other reason, the associate appeared; but it was weak and

[4] After this recognition—or simultaneous with it—a new will-act intervened. It was this new will-act that was responsible for the actual response. Therefore the response as such does not give us a measure of the initial will-act or of its consequent determining tendency.

did not incline the Subject to respond with it. This was because he still had some attention centered on the task; as seems clear from the fact that immediately after its appearance, the associate lost all interest for the Subject, who thereupon turned to the colour which was to convey to him the meaning of his yet unknown performance. Therefore we think that Selz, too, is right when he says that correct responses are due to concentration of attention; but the attention must be concentrated in the actual period of reaction.

Ach observed that in general the Reaction Times were shorter for false reactions than for correct ones, and that false reactions affect all the time values, lengthening the latter.[5] Now, if the only factors determining the nature of the response were the determining and Reproductive Tendencies, it is hard to understand such increases; for, in that supposition, the stronger the determining tendency, the more easily it should sweep aside the obstacles induced by the inclination to respond with the associate; and the more quickly it should issue in a correct reaction.[6] Some other factor must intervene to lengthen the Reaction Times. Rux shows that it is not a concentration of attention in the foreperiod. Our experiments indicate that it is attention to the task during the actual time of the reaction. And Ach seems to say as much when he attributes the lengthened times and correct responses that are caused by previous false reactions to "Successive Attention," which—and these are his own words—"causes the Subject to be more cautious and also makes the perception of the *qualitative* meaning of the stimulus to be more perfect."[7]

Since, then, the correctness of the response, and even the presence of the associate in consciousness, is so profoundly influenced by the quality and direction of attention which is given to the task, it follows that the Associative Equivalent is far from being a scientific measurement of the strength of will. We

[5] Ach, N., Ueber den Willensakt und das Temperament, p. 49.

[6] It will be remembered that Ach maintains that an "Intendiert Fehlreaction" causes the Subject to make a more energetic determination—which latter precludes further false reactions. (Cf. p. 87 of this paper.)

[7] Ach, N. Ueber den Willensakt und das Temperament, p. 49.

admit this possibility; there may be cases when the only factors concerned are the determining tendency set up by the acceptance of the instructions, and the Reproductive Tendency established by previous repetitions. In such cases there is a push of one blind force against another, and it seems logical to suppose that the one which prevails is the stronger. In that instance the Associative Equivalent may be a fairly accurate gauge of the strength of the initial will-act. But the chances of having such a clear cut case are precarious. A multitude of other factors may enter in to influence the reaction. Many of them would prove to be against our expectations, and others would be beyond our provisions. The conditions of the experiment might automatically focus attention at a critical point—as ours did. The same result might be obtained because of some accidental characteristic of the stimulus, and so on. Whatever the cause might be, there would be a new will-act elicited, and it is to this new will-act that the response is primarily attributable. The determining tendency might not affect the reaction at all. Considered objectively, this second will-act might be very weak compared to the initial one which the Subject elicited when he accepted the instructions. Yet, because of the time and circumstances in which this second act is elicited, it may suffice to counteract a given Reproductive Tendency against which a relatively stronger initial will-act would prove inefficacious. On the other hand the second act might be equal to, or stronger than, the first. But how are we to know this from the Associative Equivalent? There are no false reactions in any case, and it is from false reactions that we argue to the strength of the Associative Equivalent. The conclusion we draw is that the correctness of the response is a fallible and unscientific norm for measuring the strength of will, unless we restrict it to those cases in which we are sure that the only factors entering into the operation, are the determining and Reproductive Tendencies. It seems to us that such cases are both rare and difficult to substantiate.

THE BREAKING OF HABITS

In our consideration of the results of our experiments, we have stressed the fact that there is no evidence that the associate syllable of the stimulus hindered our Subjects in the execution of their task.

1. The Reaction Times were not lengthened in a way which would indicate an inhibitory influence on the part of the associate. This is evident from the figures in Table III on page 23. There it is shown that the Reaction Times for unlearned syllables, which had no associates, were longer, on the average, than those for the learned syllables, which did have them.

2. The associate syllable of the stimulus appeared most infrequently in the verbal response. Only once was it given definitely; in two other instances the response was a mixture of the associate and the word called for by the instructions. (Cf. Mistakes, pp. 49-50.)

3. In regard to the psychogalvanic reflex, the average percentage fall in resistance is greater [1] for the learned syllables than it is for the unlearned. On the theory that conation excites the reflex, this might be interpreted as meaning that the associate did inhibit the reaction. In other

[1] The following are the average percentage falls in resistance for five Subjects with all the tasks for both learned (1), and unlearned (2), stimuli. The figures in parentheses show the number of reactions.

	Rhyme	*Transposition*	*Change of Vowel*	*Choice*
(1)	3.01 (82)	2.98 (87)	2.95 (90)	2.43 (85)
(2)	2.29 (88)	2.35 (82)	2.35 (90)	2.39 (91)

Only learned syllables were used during the first five days when the Subjects were less attuned to the conditions of the experiments. *De facto* the average deflections for these days are higher than for any other group of five days. This partially accounts for the relatively high average when only learned syllables were used as stimuli. Still it does not completely explain the discrepancy between the two sets of averages.

words, in the performance of the same tasks more conative effort was required in the case of the learned syllables than in that of the unlearned. And it would be logical to suppose that this greater conation was exercised in overcoming the inhibitory influence of the associate. This may be the case, but we do not venture to maintain that it actually is; for, as we have said before, other factors were present which may well explain the differences in the reflex. Though we think our evidence proves that conation does produce a psychogalvanic reflex, we do not claim that the size of the deflection is an exact measurement of the amount of the conation. In the first place, we have no units for such a measurement, and secondly, so many other factors may intervene to cause the deflection, that in our present state of knowledge, it would be premature to attempt any mathematical estimation of the effect produced by any one of them. Since, moreover, we have no clear-cut evidence of inhibition on the part of the associate, either from Reaction Times, or from the form of the verbal response, we hesitate to argue to the presence of such an inhibition from the psychogalvanic reflex alone.

Towards the end of our experiments we introduced a change into our method of procedure. It proved to be better adapted for studying the "conflict" between two opposing tendencies, than had been that which relied on the strength of word-association to furnish the basis of the "struggle."

After repeated reactions the Subjects became so habituated to recognizing the meaning of the colour of the stimulus, that they understood the nature of their task spontaneously—automatically—and immediately upon the exposure of the stimulus. When this stage was reached the instructions were changed to:

"You will be shown a set of syllables of different colours. Rhyme *everything* you see and react as quickly as possible."

On another day the instructions would be changed to:

"Reverse every stimulus,"
or
"Change every vowel," etc.[2]

[2] As is clear, these conditions are like those under which Ach's Subjects

Unfortunately this new method of procedure was used with four Subjects only and not often with them, because the summer vacations began shortly after the modification was made.

It will be remembered that the various tasks were symbolized in four different colours. C had been familiarized with the meaning of these colours in a preliminary, learning series of 128 reactions. After that he reacted to the different colours 128 times. In consequence he was so well habituated to recognizing the task carried by the colour, that he did so practically automatically. Then he was told to rhyme every stimulus that appeared, regardless of its colour. The following introspections make it clear that there was a severe struggle between the tendency to react according to the old instructions and the determination to fulfill the new ones.

> (Stim. NAUR (EK) in green, which meant, in the former instructions, to reverse): "I saw NAUR, green, and the R was very clear.[3] I was on the point of reversing it when I was held up. I was bewildered and my attention seemed to lack direction. I tried to find the cause of the bewilderment and then the instructions "rhyme everything" came auditorily. With a strong effort I succeeded in getting SAUR, pronounced it with inner speech and reacted." (First Reaction.)

The next two introspections report the same sharp struggle between the tendency to respond in the old fashion, and the determination to carry out the new instructions. But on the fourth reaction a change is observable.

> (Stim. LUP (AC) in black, meaning change the vowel, in the former conditions): "I perceived LUP, black. There

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worked. The main difference is that his Subjects, and those of other investigators, reacted against an association between two syllables, whereas our Subjects had to suppress a tendency to react to an association between a syllable and its colour.

[3] In the chapter on the Nature of the Response, we have described how the task came to be recognized under the form of a focussing of attention on that particular part of the stimulus which was to be the starting point of the future reaction. In the case of the green syllables (i. e., when the stimulus had to be transposed), it was the last letter of the stimulus which was prominently present in consciousness.

was no explicit tendency to change the vowel, but there was a holdup as though a forward movement had been checked with great suddenness. Then a period of great annoyance, doubt, and helplessness. Then I seemed to take hold of myself and bring myself to do something which was not explicitly cognized and from which I shrank. After a struggle I succeeded in becoming conscious that I had to rhyme and gave the response." (C, fourth Reaction.)

It is seen that as early as the fourth reaction, the force of the habit has been broken to the extent that the tendency to respond with it, is no longer explicit in consciousness. This same phenomenon is even more marked in the introspections of E. He had had a preliminary series of 120 reactions to become acquainted with the meaning of the colours; then he reacted 160 times by fulfilling the tasks symbolized by them. After that he was instructed to rhyme "every stimulus that appeared regardless of its colour."

(Stim. KAER (EL) in green): "When I saw the green KAER, there was a short period of blank in consciousness. Then came a very strong tendency to reverse, and I had a very clear image of the word 'reversed.' I felt a strong striving to repress this, shifted my attention to the K, and after a short pause responded SAER." (Second Reaction.)

(Stim. LUP (AC) in black): "When I saw the black LUP, there was a short blank, but no conscious tendency to do the usual reaction (i. e., change the vowel of the stimulus). Still the U was quite clear. After a short blank I looked at the stimulus again, and the beginning of the word became clearer. Responded GUP with a feeling of satisfaction. There was very little struggle against the old tendency." (Fourth Reaction.)

D had 160 preliminary experiments in learning the meaning of the colours, after which he reacted to them 176 times. Then he was instructed to reverse everything.

(Stim. NAUR (EK) in black): "I read NAUR, black. Following the recognition of the colour, my mind seemed to start on an easy forward movement. There was a sudden check on this, followed by a complete hold up and hesitation. I was not explicitly aware of the old instructions of 'change

the vowel,' though the diphthong was prominent in awareness. An indefinite struggle was going on in my mind. Then 'reverse everything' arose, and I reacted RUAN with relief." (First Reaction.)

(Stim. LUP (AC) in blue, which was the choice reaction of rhyming or reversing, with the old instructions): "I saw LUP, blue, and there was a vague thought of 'reverse' and of 'blue rhyme or reverse.' Then the thought of today's instructions and a little surprise that they coincided with the old one (i. e., 'blue, rhyme or reverse'). I reacted PUL with little effort, and a feeling of satisfaction that things had gone off so nicely." (Seventh Reaction.)

The above introspections are characteristic of the processes reported independently by C, D, E, and F. At first there is a very sharp struggle to respond to the colour in the old, habitual way. After a very few—three or four—successful reactions to the new instructions, this tendency becomes rapidly and progressively less intense. It reappears, however, in new conditions. For instance on the second day, the Subjects were instructed to reverse every stimulus that appeared, and on the third, to change every vowel. The old tendency is stronger in the first few reactions to the new instructions, than it was during the later reactions of the day before. But each succeeding day it is subdued more quickly and with less difficulty.

A rather curious phenomenon was observed and reported by the Subjects. After the first few reactions under the new conditions, the principal difficulty was experienced when the old and the new instructions over-lapped in the stimulus. For example, when a red stimulus appeared in a series of exposures in which the instructions were to "rhyme everything," the Subject had a double impulse to rhyme, that arising from the new instructions, and that linked on to the meaning of the red (viz., to rhyme) in the previous conditions. The acceptance of the new instructions set up a determining tendency to rhyme which functioned smoothly enough with the other colours, but was impeded more than ordinarily when a red stimulus appeared. Evidently the colour forms a complex with the different instructions which operates in different ways. In the old instructions red meant

rhyme; when the instructions were "reverse everything," red meant to reverse. In that case "red—rhyme" was the past situation; "red—reverse" was the present, and influenced the present reaction. When, however, the instructions were "rhyme everything," and a red stimulus appeared, there was a complication between the two situations. The Subject was influenced by the determining tendency set up by the new task, and he was also actuated by his habitual tendency to respond to a red stimulus by rhyming it. In other words he was being influenced by a double motive, whereas he was accustomed to one only. The result was a confusion which lengthened the Reaction Time and was finally resolved by the recognition of the fact that the old and new instructions were equivalent. As one Subject put it:

> "then, with surprise and pleasure, I recognized
> this (a red syllable) is rhyme."

The reactions under the new conditions described above were too few to furnish usable quantitative data.[4] The qualitative results reported in the introspections point to the facts that:

1. In the beginning the old tendency to respond with the task symbolized by the colour, was very strong.

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[4] There were only eighty-six reactions under the new conditions, distributed as follows:

To the instructions "rhyme everything," E reacted twelve times; C, six; D, ten; F, eight. With instructions "reverse everything," E reacted twelve times; C, eight, D, ten. To the instructions "change the vowel," E reacted twelve times; C, eight. For so few reactions the Reaction Times are negligible. We might note that when E had only to rhyme or only reverse, etc., his Reaction Times are longer than when he performed these same tasks by responding to the colour of the stimulus. The three other Subjects, on the contrary, always responded much more quickly to the new instructions than they did to the old.

The psychogalvanic deflections are as few as the Reaction Times, but they exhibit a notable phenomenon. Whenever the Subjects were instructed to react in a different way to that to which they had been accustomed, there is a marked increase in the size of the deflections for the first few reactions. For instance, when E was put to rhyme all the stimuli instead of reacting to the colour, his average percentage drop in resistance for the first four reactions was 10.5 per cent, while for the following eight, it was 3.5 per cent. The same difference is observed in the deflections of the other Subjects. For the first few reactions more conative effort was required to overcome the opposing tendency. Besides, the new situation excited the Subjects by its unfamiliarity.

2. Each successful reaction lessened the influence of the habit, and this ceased to function consciously in a remarkably short time. It flared up anew whenever new instructions were given, but in those conditions it died down again rapidly and was subdued more easily than it had been on the first day.

3. The issue of the struggle between the two conflicting tendencies was consciously determined by the Subject. He interfered to direct the flow of his conation at the critical moment, when the stimulus was exposed. That is, the issue was not left to the unconscious operation of the determining tendency against the strong force of the habit previously formed. There were no false reactions.

4. There was one will-act made when the Subject accepted the new instructions. There was another distinct will-act when the two tendencies clashed; and it was this will-act that was immediately responsible for the specific reaction in the individual experiments.

We have said above that a new determining tendency was set up by the voluntary acceptance of the new task. It manifested itself in this, that the Subjects were checked in their tendency to respond to the colour of the stimulus as they had been regularly doing before. They were conscious of this check immediately upon the exposure of the stimulus, even when they were not formally conscious of the new instructions. This determining tendency prevented a spontaneous, explosive, reaction let loose by the force of the habit, and the result of this hold-up was that the Subject directed his attention towards another possible outlet of energy. He ascertained what that was, by a recall of the instructions, and it was this recall which furnished the direct motive of the reaction. And, therefore, the determining tendency set up by the task operated only indirectly in the production of the verbal response as such; it prevented a purely automatic response which would have precluded the possibility of a real volitional reaction.

Surely this does not constitute a will-act as it is understood by the majority of men and exemplified in the daily life of individuals. When there is a conflict of impulses; when, as was

the case in our experiments, an inclination to carry out an accustomed reaction militates against a determination to react in a different way, there are two possible outlets for the agent's activity. Unless he intentionally directs his activity into one of these two channels in preference to the other, there is no volition exercised at all. There is simply the push of two blind forces against each other,—the stronger will oust the weaker.

We admit that the determining tendency is the result of a will-act. This will-act looks to the achievement of a certain end and includes besides, at least implicitly, the resolve to employ the necessary means of attaining it. In some cases this primary act of will is sufficient to bring about a correct response. The right means are used and the desired result obtained without any further conscious direction on the part of the agent. That happens in the case of the skilled pianist. He voluntarily begins the playing of a piece with which he has voluntarily made himself thoroughly familiar. He initiates the process volitionally, but it is carried through as a chain-reflex. The conative energy he expends in the execution of the piece is an act of will only in so far as he started it voluntarily, and then did nothing to impede the flow of the movement. The individual components of the total act follow on each other spontaneously and automatically, the preceeding one arousing and directing the succeeding. It is not the strength of the initial determination to play, which guides the conation to make the appropriate movements; it is the completeness of the association between the individual movements themselves. Once the series of actions is inaugurated, it takes care of itself whether the player began reluctantly or with enthusiasm. Moreover, and this is important, the succession of movements must be continuous if they are to be referable to the initial act of will. If the succession is broken, a new conscious direction of conation—in other words, a new will-act, is necessary in order to start the reflex anew.

Now the successive operations of the chain-reflex may be linked together so firmly as to brush aside an impeding obstacle of considerable weight; then the operations continue uninterruptedly in virtue of the reflex itself. If, however, the obstacle

is of such a nature as to interfere with the functioning of the reflex, the chain is broken, random movements result, and the playing may be stopped entirely. In that case, as we have said, a new will-act must intervene to regulate the conative activity and guide it into the right channels again. The reason is that the initial will-act, which operated only indirectly in the uninterrupted flow of the reflex, has ceased to function since the reflex no longer proceeds smoothly. In either case, whether the reflex prevails and the continuous movement progresses, or the obstacle succeeds in checking the reflex, the issue is independent of the original strength of the initial will-act.

It seems to us that essentially the same principle holds in regard to the operation of the determining tendency aroused by the acceptance of a task. It is a question of association. The acceptance of the instructions sets up a determination towards the general realization of the task. This is voluntary. For the sake of concreteness, let us say that this general tendency is to rhyme every stimulus which is exposed. We concede that the strength of this general tendency bears some relation to the strength of the will-act which elicited it. But this general tendency is not sufficient; there must be another tendency, namely, one to control the conative activity and direct it to rhyme the *specific* stimulus which appears. The nature of the response will depend on the strength of association between these two tendencies. If that association is strong enough, it will push through an obstacle which tends to hinder its operation. If it is relatively weaker than the inhibiting force, this latter will gain the ascendency and determine the response.[1] When the obstacle is the

[1] It might appear that there is a contradiction between what is said here and what is argued in the chapter on Results. In that chapter we maintained that the correctness of the response depends on the quality of attention given to the reactions at the critical moment of the exposure of the stimulus. It might seem that we now claim that it is due to the strength of association between the general tendency to rhyme, and the more specific tendency to rhyme that particular syllable which is exposed. But this strength of association is only a mechanism for bringing about the requisite focussing of attention. In certain conditions the strength of association is the means; the focussing of attention is the end. They

tendency to reproduce the associate syllable of the stimulus, it is this associate that will most probably appear in the reaction. But whether the response is the desired rhyme or the undesired associate syllable, it is the result of a struggle between two blind forces: between (1) the association existing between the general tendency to rhyme, and the tendency to confine that activity to produce a *definite kind* of rhyme, and (2) the association between the stimulus and its companion syllable. All this is on the supposition that the only will-act entering into the process is the initial one which set up the unconscious determining tendency. Therefore, even when no further will-act is involved, the Associative Equivalent is not an accurate measure of the strength of will. For it measures the will-act only indirectly, through the strength of an association induced by it. Though that may be a closer approximation to the actual strength of the initial will-act when we deal with the determining tendency, than when we try to gauge the pianist's volition by means of his chain-reflex,[6] it certainly seems to lack the scientific exactness which would make it valuable as a means of measurement.

If another will-act enters into the process, if at the moment of conflict between the diverse tendencies, the Self steps into the arena and favours one conative tendency while it inhibits the other, then the Associative Equivalent does not measure anything at all: in fact, in that case there can be no question of an

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both operate to influence the reaction, but in different ways. And, therefore, there is no contradiction.

[6] We do not wish to push the analogy between the reaction of the pianist and that of a Subject in his reactions to experiments, too far. There are vast differences, of course, between the pianist's chain-reflex and the determining tendency of a Subject in a laboratory. The latter arouses his tendency to a certain kind of reaction by a pure act of will, while the chain-reflex is not so restricted in its causes. The frequent practises which laid it down are voluntary, so were the different individual movements, which later became automatized. But auditory, visual, kinaesthetic, and other sensations all enter into the mechanism. What we stress is this: once the association is formed and the process voluntarily initiated, the conative energy involved in carrying out the series of associated actions, is not directed by volitional control in the actual performance of the task. It is the same condition as obtains in ordinary "habitual" activities.

Associative Equivalent. For this is recognized in the false reactions, and as we have insisted in the chapter on Results, there are no false reactions when the Self interferes in such a directive way.

The general conclusion, then, is that the determining tendency is not adapted to a scientific measurement of will activity, and we must seek some other means of gauging the strength of will. Personally we are not inclined to be enthusiastic over the prospects of finding an exact scientific measurement of will-activity. Of course people may be roughly classed as "strong willed" or "weak willed," and the general classification is in the main correct. It may be refined by further study and experimentation. But we doubt that will-activity can ever be measured with the accuracy we are justified in hoping for in the case of memory, or even of "intelligence," and these measurements are poor enough. The reason is because the will is more capricious in its activity than is the memory or the intellect; it is more profoundly influenced than they by past experience, environment, education, and a host of other factors. Moreover, it essentially depends on the intellect in its activity, since no one can choose or desire or exercise any other rational volitional act, unless he cognizes the object of his desire or the motive of his choice. And this intimate relation between will-activity and "intelligence," introduces new variables into the question of the will-act and makes its study correspondingly more difficult and uncertain.

CONCLUSIONS

We began our research with the intention of studying conational activity with a view of measuring it, at least in some rough way. We must confess that we have not succeeded in doing so. Our data show that the psychogalvanic reflex is influenced by conation, and that the size of the deflection bears some proportion to the amount of conative energy released during the reaction. But the psychogalvanic curve is such a complicated one, resulting from so many different causes and modified by such a variety of factors, that we do not think it is (in the present state of our knowledge of it), a serviceable measure of conation. In fact our experiments have practically convinced us that it is futile to hope for anything like an exact scientific measurement of conation, especially when that conation is intentionally directed and thus constitutes a real act of will. Before advancing our arguments in support of this opinion, we shall briefly summarize the main facts which came to light during the process of our research.

1. There is no evidence to show that the Reproductive Tendency exerted an inhibitory influence on the Subjects' reactions. Neither the Reaction Times nor the psychogalvanic reflex conclusively point to the presence of such an inhibition.

2. The associate syllable of the stimulus was given as a response exceedingly rarely (three times in 652 reactions). Moreover, the introspections in these cases show that the false reactions were probably due to other causes than to the influence of the Reproductive Tendency.

3. The phenomena noted above (in (1) and (2)), are contrary to the experience of other investigators who have studied will-activity along lines similar to those we followed. The explanation of the discrepancy is traceable to a difference of method. The conditions of our research focussed

attention in a way theirs did not. The result was that with our Subjects the influence of the Reproductive Tendency was lessened or suppressed, and false reactions precluded.

4. When we changed our conditions so as to approximate those of other investigators, the Associative Tendency operated forcibly, as had been the experience with them. In that case the issue of the conflict between the opposing tendencies was determined by the conscious interposition of the Self.

5. A habit was quickly and automatically broken when the reagent attentively applied himself to a course of action antagonistic to it. Each successful reaction noticeably lessened the tendency to give the habitual response. After a very few initial reactions no positive effort was required on the part of the Subject, to overcome the force of the habit. This was mechanically subdued, provided the Subject brought sufficient attention to his new task.[1]

6. The task which our Subjects regarded as the easiest of all, was the one in which the most mistakes were made. The explanation suggested by the introspections, is that the very ease of this task was responsible for the high percentage of error. Just because it was regarded as easy, the attention given to it was often not close enough to ensure a correct response.

From all the above it is manifest that attention plays a rôle of paramount importance in the exercise of volition. In itself, attention is not merely an act of will. Cognitive elements enter also. A conative act directs the cognitive energy to a present experience with the result that this latter assumes a clarity and

[1] Theoretically any habit can be broken automatically by fixating the attention on an antagonistic course of action. But when the habit is a physical one, when an organic craving clamours for satisfaction or the discharge of one set of neurons incites another set to react, other considerations enter in. In such circumstances the difficulty is to get the individual to concentrate his attention on the opposing course of action. In our experiments such concentration was brief and easy. In ordinary life the period of conflict is long; the organic cravings draw attention to themselves, thus draining it away from the realization of the ideal, or ambition, or course of action, to which the habit is opposed.

intensity which would have been lacking, had the experience been given less close attention. The increased clearness and force effected by the attention, increases the motive force of this experience, and thus reacts on the mind's further conative activity. And this is the reason why we said above, that we are not sanguine of finding an exact measurement of conation. The profound influence that attention exerts on voluntary activity, and the way it can subordinate the stronger motive to the weaker, makes the hope of objective measurement very faint. We may set up obstacles to the exercise of the will-activity. We may gauge the opposing strength of such hindrances to a fair degree of accuracy. The number of repetitions, for instance, is a workable measure of the strength of a Reproductive Tendency. Yet such artificially created obstacles lose their value as objective norms, owing to the selective operation of attention.

In certain conditions I can estimate the relative strength of two physical forces from the study of their components. Similarly, in a vital reaction, if two blind antagonistic reflexes or instincts were to react against each other, with relative measurable strengths of ten pounds and six, I could predict the consequent reaction with approximate precision. But when the power of selective attention intervenes in will-activity, the relative strength of rival motives is modified. The ten pound force may be made to pull with a force of five or of one, and the six pound force may increase its pull to eight, because of the preferential attention I give to it. And thus a factor enters into the process which is arbitrary in its action and destructive to hopes of objective measurement.

We are justified in assuming that our Subjects had set up a strong tendency to reproduce the associate of the stimulus. They had repeated the associated pairs of syllables more frequently than had the Subjects in other investigations, who responded with the associate syllable against their desire to react according to contrary instructions. Our Subjects were not influenced in their reactions by the Reproductive Tendency, not because this was objectively weaker than the tendency aroused by their acceptance of the instructions, but because their attention was directed in

such a way as to affect the relative value of the two tendencies. The force of the Reproductive Tendency may have been the stronger objectively, but it was rendered subjectively weak, because the attention was centered on the task in hand. The available mental energy was occupied with this task, with the consequence that the motive strength of the rival tendency was automatically diminished. Now such a selective action of attention may be brought about by the conditions of the experiment, by some special interest attaching to the perception of the stimulus, by the Subject's own mental habits, and by a host of other factors. Which of these enter into a given voluntary process, and to what extent? It is exceedingly difficult to say. And until we can regulate the play of such factors, there is small prospect of measuring the strength of individual will-acts.

The whole difficulty has been put forward by James in his *Principles of Psychology.* Having asked what would be the effect of an effort to attend, supposing that there is such an original force, he answers:

> It would deepen and prolong the stay in consciousness of innumerable ideas which else would fade more quickly away. The delay thus gained might not be more than a second in duration—but that second might be *critical*; for, in the constant rising and falling of considerations in the mind, where two associated systems of them are nearly in equilibrium it is often but a matter of a second more or less of attention at the outset, whether one system shall gain force to occupy the field and develop itself, and exclude the other, or be excluded itself by the other. When developed it may make us act; *and that act may seal our doom.* The whole drama of the voluntary life hinges on the amount of attention, slightly more or slightly less, which rival motor ideas may receive. But the whole feeling of reality, the whole sting and excitement of our voluntary life, depends on our sense that in it things are *really being decided* from one moment to another, and that it is not the dull rattling off of a chain that was forged innumerable ages ago.[1]

[1] James, op. cit. Vol. 1, p. 453.

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McCARTHY, RAPHAEL C., S.J.
AUTHOR
The Measurement of Conation
TITLE
DATE LOANED
BORROWER'S NAME
ROOM NUMBER
APR 9
STORAGE -
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